PROPOSAL FOR RECONNAISSANCE SURVEY (G-4) FOR PHOSPHORITE IN KAPHALDA BLOCK (16.68 Sq. Km), DISTRICT- DEHRADUN/TEHRI-GARHWAL, UTTARAKHAND

COMMODITY: PHOSPHORITE

BY

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NAGPUR, MAHARASHTRA

PLACE: NAGPUR

DATE: 12.01.2025

SUMMARY OF THE BLOCK FOR RECONNAISSANCE SURVEY (G-4)

GENERAL INFORMATION ABOUT THE BLOCK

	Features	**Details**
	Block ID	Kaphalda Block
	Exploration Agency	Mineral Exploration & Consultancy Limited (MECL)
	Commodity	Phosphorite
	Mineral Belt	Mussoorie Syncline
	Completion period with entire Time schedule to complete the project	12 months
	Objectives	The objectives of current program would be: 1. Preparation of Geological map at 1:12,500 Scale. 2. To collect surface (Bedrock) samples for analyses of Phosphate and associated minerals. 3. To prove the mineralized zones by bedrock sampling for the outcrops, pitting, trenching and scout drilling. Scout drilling holes to be planned at convenient intervals, in the blocks exposing sections of Krol-Tal contact, cherts, phosphate rock and the overlying shales in order to measure the thickness of phosphatic horizons and associated rocks and to study their lateral and vertical relationship. 4. To upgrade the block in G-3 and facilitate the state govt. for auctioning of the block.
	Whether the work will be carried out by the proposed agency or through outsourcing and details thereof. Components to be outsourced and name of the outsource agency	Work will be carried out by the proposed agency.
	Name/Number of Geoscientists	02 Geoscientist
	Expected Field days (Geology, surveyor)	180 days Geologist Field days
1.	**Location**	The proposed block area for G-4 falls under the majorly under Survey of India Toposheet number 53J/3. The prominent places in the area are Kaphalda, Silla Sera, Bhanswalgaon, Kyar kuli bhatta, Simiyari, Fuleta, Durmala, Bhusti, Chhamroli of Raipur Block,

		Dehradun district. Dehradun city is located about 33 km west of the block and could be approached by motorable metaled and kachha roads from Dehradun.
	Latitude and Longitude	<table><tr><th>LABEL</th><th>LONGITUDE</th><th>LATITUDE</th></tr><tr><td>A</td><td>78.1608994°E</td><td>30.4147694°N</td></tr><tr><td>B</td><td>78.1823790°E</td><td>30.4400741°N</td></tr><tr><td>C</td><td>78.2197475°E</td><td>30.4109443°N</td></tr><tr><td>D</td><td>78.1963554°E</td><td>30.3859338°N</td></tr></table>
	Villages	Kaphalda, Silla Sera, Bhanswalgaon, Kyar kuli bhatta, Simiyari, Fuleta, Durmala, Bhusti, Chhamroli
	Tehsil/Taluk	Raipur/Dhanaulti
	District	Dehradun/Tehri-Garhwal
	State	Uttarakhand
2.	**Area (hectares/ square kilometres)**	
	Block Area	16.68 sq.km
	Forest Area	Sila Reserved Forest falls in the Block area
	Government Land Area (Bilanam)	Data not available
	Charagaha	Data not available
	Private Land Area	Data not available
3.	**Accessibility**	
	Nearest Rail Head	Dehradun is the nearest railway station about 33 km.
	Road	The Maldevta-Dubra Motorable kachha road passes near the block. Metaled roads are not available in the area.
	Airport	Jolly Grant, Dehradun is the nearest airport about 35 km.
4.	**Hydrography**	
	Local Surface Drainage Pattern (Channels)	The drainage of the area is of consequent type. The water of southern slope of Mussoorie ridge (between Mussoorie and Agarakhal–Nagani) drains into the Ganga through many streams, the prominent among them are Suswa Nadi, Song, Jakhan Rao, Chandna Rao and Huinl (Hewnal) river. Among these, these Song River carries the maximum water, and its main tributaries are Kaligad, Bandal and Chiphaldi nala. Song River and its tributaries drains the proposed block. The water of the northern slope of Mussoorie

		ridge, flows through various streams into the Aglar, a tributary of the river Yamuna.
	Rivers/ Streams	Song River.
5.	**Climate**	
	Mean Annual Rainfall	The rains are generally heavy and continue upto early September. The mean annual rainfall is about 250 cm.
	Temperatures (December-June) (Minimum-Maximum)	The area experiences fairly warm temperate climate with warm summer and cold winter. Particularly, the valley floor is warmer. Winter spans from November to February. The area experiences appreciable amount of rainfall during the monsoons which ranges from the middle of June to middle of September. The prevailing climate is sub-tropical below altitudes of 1,200 m from March to June, whereas in areas above 1,600 m, the temperature is comparatively lower, a few places experience snow-fall during the winters. By and large the area is forested. The vegetation consists mainly of pine forest in the high hills. The slopes support prolific growth of dense mixed forest of pines and some other trees too with some bushy and shrubby vegetation occurring here and there.
6.	**Topography**	
	Toposheet Number	53J/03
	Morphology of the Area	The area under report lies on the outermost fringe of the Lesser–Himalaya of Garhwal, immediately to the north and north-east of the Siwalik foothills and the Doon Valley. The main topographic feature of the area is the imposing ridge, trending roughly E-W to ENE-WSW lying to the north of the broad Dehradun Valley between the rivers Yamuna on the west and Ganga on the east. The region is characterized by rugged mountainous terrain in the Lesser Himalayan zone, with steep slopes, deep valleys, and ridge-like formations shaped by tectonic activity and weathering processes. The drainage patterns are predominantly dendritic, with a mix of trellis and rectangular patterns in certain areas due to intense tectonic activity and proximity to the Main Boundary Thrust (MBT). Numerous spurs branch off in diverse directions from the main ridge. Rugged topography, so characteristic of the Himalayas and typical of any young fold mountain, with hill ranges rising steeply from 1200 meters to over 2100 meters above mean sea level and deeply cut

		valleys, clothes with a verdant cover of Pine, Deodar, Rhododendron, and Oaks at higher reaches, and bushes and shrubs at lower altitudes, dominate the landscape. The alignment of ridges and valleys at places suggests that the topography is somewhat mature and of the second order. The synclines forming the ridges, such as the Lal-Tibba ridge forming the core of the main Mussoorie Syncline and the Castle-Hill-Paritibba ridges, reflect minor synclinal digitation.
7.	**Availability of baseline geoscience data**	
	Geological Map (1:63K/50K)	NGDR/PPCL Geological Map
	Geochemical Map	NGDR
	Geophysical Map (Aeromagnetic, ground geophysical, Regional as well as local scale GP maps)	Gravity & Magnetic Data (NGDR)
8.	**Justification for taking up Reconnaissance Survey/ Regional Exploration**	• The proposed Kaphalda Block, located in the Mussoorie Syncline, is surrounded by significant phosphorite deposits like Kimoi, Masrana, Durmala, Silagoan-Bhusti, and Bhusti-Jhamthiogaon, previously explored by GSI and PPCL. • Durmala Block, a prominent phosphorite zone, exhibits phosphate beds varying in thickness (0.40 m to 4.0 m) and grades (17% P2O5 to 30% P2O5), with an ore body continuity over 5.7 km between Masrana and Bhusti at altitudes of 1650–1950 MRL. • Phosphatic beds in these areas are associated with black cherts and shales of the lower Tal Formation. However, lateral intertangling relationships between the units have been observed. • The Kaphalda Block lacks exposed phosphate beds, as noted during PPCL mapping, but systematic exploration is needed to confirm continuity with the high-grade deposits in Block areas. • Geological similarities and the high-grade potential of adjacent blocks make the Kaphalda Block a promising prospect for detailed exploration to establish its phosphorite resources.

PROPOSAL FOR RECONNAISSANCE SURVEY (G-4) FOR PHOSPHORITE IN KAPHALDA BLOCK, DISTRICT- DEHRADUN, UTTARAKHAND

1.0.0. PREAMBLE

1.1.1 Presently, India depends on imports for approximately 90% of its phosphate needs, whether in the form of raw materials or finished fertilizers. To meet the growing demand for phosphorus, the exploration of new economically viable phosphorus deposits within the country could play a crucial role in reducing this dependency. Agriculture and its related sectors continue to be the largest source of income for India. The success of agriculture is largely dependent on the fertilizer industry, which provides essential raw materials needed for crop production. Among these, phosphorus—a key nutrient in fertilizers along with nitrogen and potassium—is processed from phosphate rock.

1.2.0 INDIA'S PHOSPHATE DEMAND

1.2.1 Phosphorus is irreplaceable in agriculture, making it a vital component in meeting food production needs. However, India's reserves and resources of chemical and fertilizer grade apatite and rock phosphate are extremely limited, with only 10-15% of the phosphate fertilizer production being sourced domestically. The remaining 85-90% of the demand is met through imports, including rock phosphate, phosphoric acid, and direct fertilizers. The demand for phosphatic fertilizers is expected to rise steadily, driven by population growth and increased food requirements.

1.2.2 The Government of India is taking significant steps to achieve self-reliance in fertilizer production. This includes the establishment of new manufacturing units aimed at reducing import dependency. Highlighting the focus on domestic exploration, the Minister of Chemicals and Fertilizers, Shri Jagat Prakash Nadda, announced initiatives to explore indigenous phosphatic rock deposits as part of the "Aatma Nirbhar Bharat" campaign. Furthermore, the government allocated fertilizer subsidies of ₹1.19 trillion (US$ 15.97 billion) in F.Y. 2021-22 to ₹1.79 trillion F.Y. 2023-24 to support farmers and boost agricultural productivity.

1.2.0 BACKGROUND

1.2.1 The production of phosphorite and rock phosphate in India is limited and comes primarily from four State Public Sector mines. These mines are located in the following districts:

a) **Madhya Pradesh:** Chhatarpur, Sagar, and Jhabua districts each host one mine.

b) **Rajasthan:** Udaipur district hosts the largest mine.

Rajasthan continues to dominate domestic production, contributing 92% of the total output, while Madhya Pradesh accounts for the remaining 8%. According to the Indian Minerals Yearbook 2022, the distribution of reserves and resources is as follows:

c) **Jharkhand: 34%**

d) **Rajasthan: 31%**

e) **Madhya Pradesh: 19%**

f) **Uttar Pradesh and Uttarakhand**: 8% each

This regional distribution underlines the importance of Rajasthan and Madhya Pradesh in sustaining India's limited domestic phosphate production, while also emphasizing the need for further exploration and resource augmentation in other regions.

1.2.2 In order to improve the availability of phosphatic fertilizers and to reduce the dependence on imports by making India truly 'Aatma Nirbhar' in fertilizers, MECL has undertaken various exploration initiatives. Notably, in Uttarakhand, MECL has submitted the Geological Report for the Kathyur Block at the G-4 level of exploration, and this block is now proceeding towards auction under the composite license scheme. Hence, a proposal for the Kaphalda Block in the northeastern limb of the Mussoorie Syncline is being put-up for reconnaissance survey (G-4), which may facilitate state government to auction the block, further enhancing domestic phosphate production.

2.0.0 INTRODUCTION

2.1.0 BLOCK DESCRIPTION

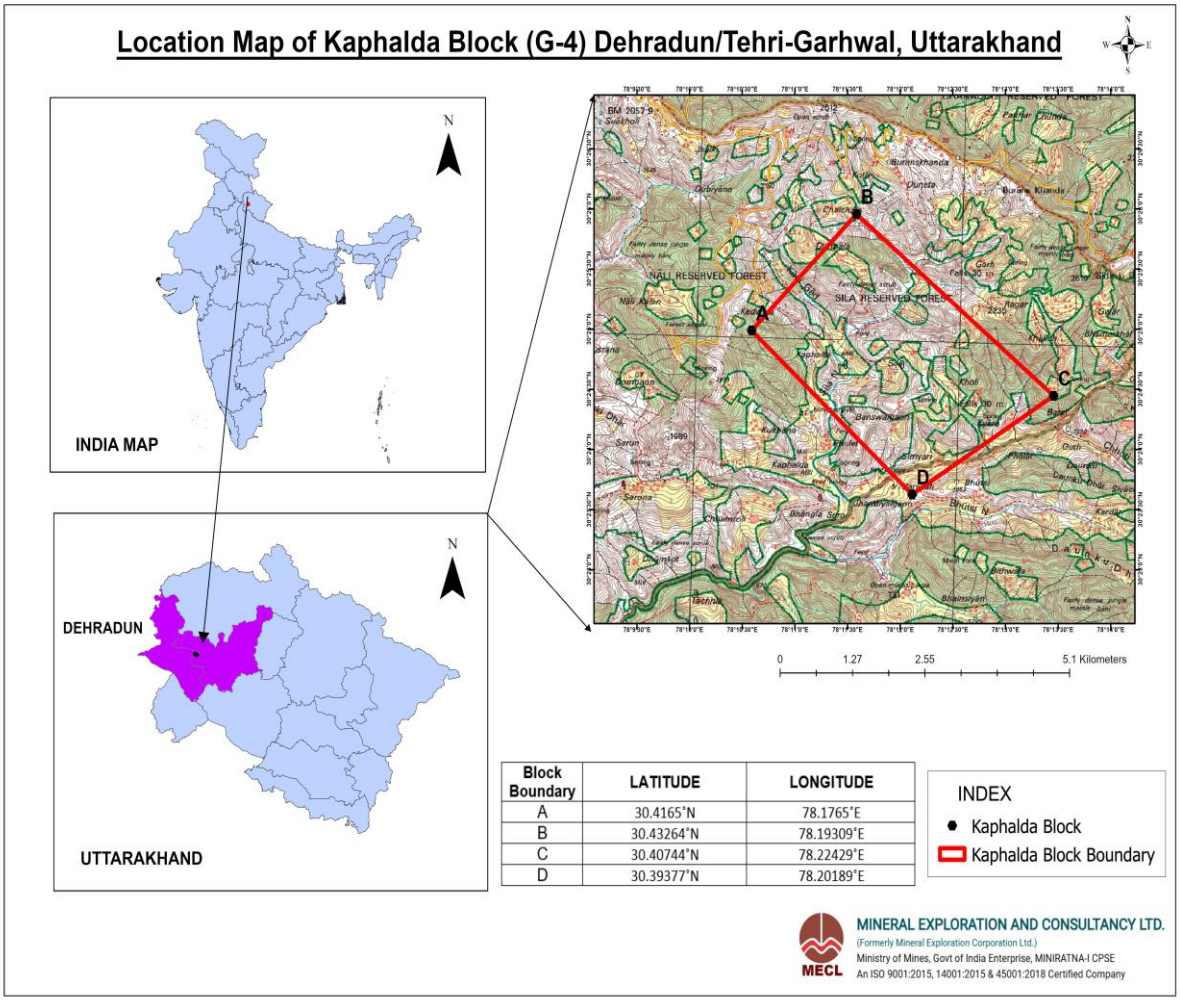
2.1.1 The Kaphalda Block area falls in Survey of India Toposheet No. 53J/03 and covers an area of 16.68 sq.km in and around villages Kaphalda, Silla Sera, Bhanswalgaon, Kyar kuli bhatta, Simiyari, Fuleta of District: Dehradun, Uttarakhand. The block is situated in Mussoorie Syncline. The block's location in the toposheet is provided in **PLATE-I.** The coordinates of the block's corner points, in both Degree Decimal and UTM formats, are presented in Table No. 2.1.

Table No. 1.1: Co-ordinates of Corner Points of Kaphalda Block.

LABEL	Degree Decimal		UTM (44N)	
	LONGITUDE	LATITUDE	X(E)	Y(N)
A	78.1608994°E	30.4147694°N	303249.53	3366701.88
B	78.1823790°E	30.4400741°N	305598.41	3370142.96
C	78.2197475°E	30.4109443°N	309065.18	3365800.12
D	78.1963554°E	30.3859338°N	306578.83	3362511.49

2.2.0 LOCATION AND ACCESSIBILITY

2.2.1 The Kaphalda Block area falls in Survey of India Toposheet No. 53J/03 and covers an area of 16.68 sq.km in and around villages Kaphalda, Silla Sera, Bhanswalgaon, Kyar kuli bhatta, Simiyari, Fuleta, Durmala, Bhusti, and Chhamroli of District Dehradun, Uttarakhand. The proposed block is well connected from Dehradun via Maldevta, and Mussoorie. The Block is situated approximately 33 km from Dehradun. Dehradun and Rishikesh is the nearest railway stations. Jolly Grant Airport of Dehradun is the nearest airport about 50 km away from the block. The important tourist places nearby the proposed block are Mussoorie, Sahsradhara, Maldevta, Rishikesh, Haridwar.



Text Figure 1.1 : Location Map of the Kaphalda Block shown on Toposheet 53J/03.

2.3.0 PHYSIOGRAPHY

2.3.1 The proposed area lies on the outermost fringe of the Lesser–Himalaya of Garhwal, immediately to the north and north-east of the Siwalik foothills and the Doon Valley. The main topographic feature of the area is the imposing ridge, trending roughly NW-SE to NNW-SSE lying to the north of the broad Dehradun Valley between the rivers Yamuna on the

west and Ganga on the east. Numerous spurs branch off in diverse directions from this main ridge. Rugged topography, so characteristic of the Himalaya and typical of any young fold mountain, with hill ranges rising steeply from 610 meters above m.s.l. to over 2590 meter above m.s.l. and deeply cut valleys, clothes with a verdant cover of Pine, Deodar, Rhododendron and Oaks at higher reaches and bushes and shrubs at lower altitudes dominate the landscape. The geomorphologic character of the alignment of ridges and valleys at places suggest that the topography is somewhat mature and of second order, with anticlines forming valleys e.g., Dhobighat-Manjkhet valley and the synclines forming the ridges e.g., the Lal-Tibba ridge forming the core of main Mussoorie Syncline and Castle-Hill-Paritibba ridges– reflecting the minor synclinal digitation.

2.3.2 The climate is tropical monsoon type, modified to some extent by the effects of altitude and the situation of the area in the continental interior. Winter is fairly severe with occasional snow falls between December and March. Summer season starts from April and the outdoor activities can best be done upto the end of June, when the monsoon breaks out. The rains are generally heavy and continue upto early September. The mean annual rainfall is about 250 cm. The drainage of the area is of consequent type. The water of southern slope of Mussoorie ridge (between Mussoorie and Agarakhal–Nagani) drains into the Ganga through many streams, the prominent among them are Suswa Nadi, Song, Jakhan Rao, Chandna Rao and Huinl (Hewnal) river. Among these, the Song River drain the proposed area, and its main tributaries are Kaligad, Bandal and Chiphaldi *nala*. The water of the northern slope of Mussoorie ridge, flows through various streams into the Aglar, a tributary of the river Yamuna.

2.4.0 FLORA & FAUNA

2.4.1 The advancing influx of population has scared away the wild animals from the area around the township of Mussoorie and other easily approachable places but the interior parts and densely forested areas are still infested with variety of wild animals, the most common one's panther, wild bear, barking deer, wild goad and jungle fowl.

2.5.0 REGIONAL GEOLOGY

2.5.1 Regionally the proposed area falls under Mussoorie Syncline. On a regional scale of Mussoorie Syncline and part of the northern limb of Garhwal Syncline. The following stratigraphic was established by Ravi Shanker, A. Ghose & V.M.K. Puri.

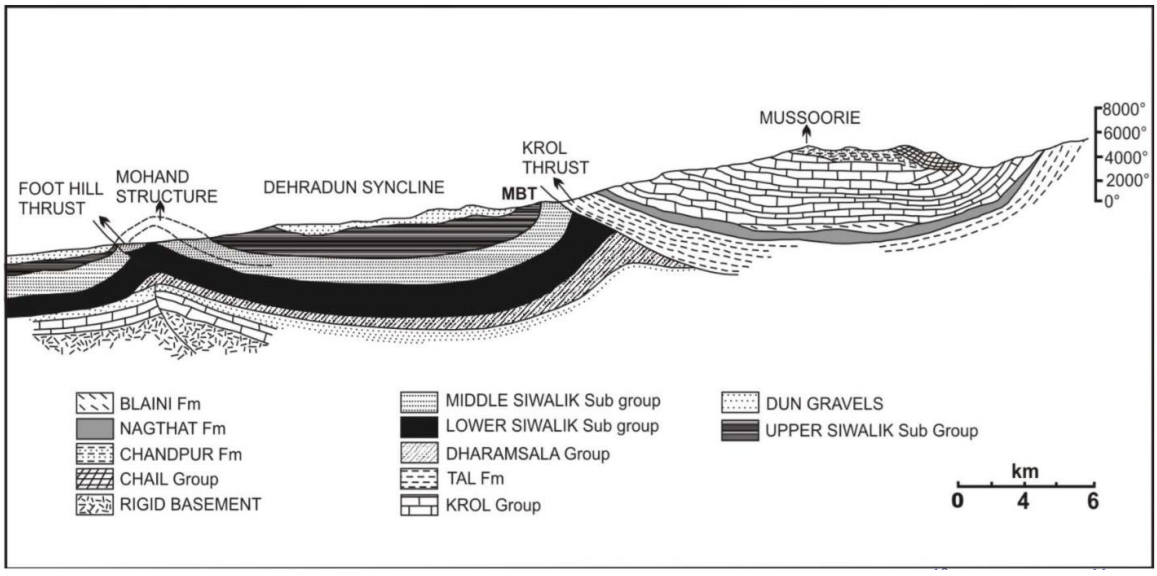
2.5.2 **Tal Formation**: The Tal Formation is divided into two main units: the Lower Tal Formation and the Upper Tal Formation, based on distinctive lithology, clear surface contacts, and easy mappability. The contact between these formations often represents a break in sedimentation

and a significant shift in the depositional environment from marine to non-marine conditions. Thus, the boundary between the Lower and Upper Tal formations is both natural and distinct.

Table- 1.2: Litho-stratigraphic classification of Mussoorie Syncline

Age	Group	Formation	Thickness
Older Paleozoic (?)	Garhwal Thrust Unit	• Schistose-phyllites limestone and quartzite volcanic tuffs	
----------Garhwal Thrust----------			
Late to Mid. Eocene	Subathu Formation	• Olive Shale, Shell-marl and Limestone	
----------Unconformity (?)----------			
Late or Mid. Cretaceous	Upper Tal Formation	• Limestone member (Shaly calcareous grits)	20 m
		• Quartzite Member	1300 m
(Sequence of Quartzite and thin grey to green shales, red siltstone, often mud cracked).			
Mid. Jurassic to Lower cretaceous	Lower Tal Formation	• Calcareous member	5 m
		• Arenaceous member (massive banded siltstone/sub-greywacke)	300 – 500 m
		• Argillaceous member	150 m
		• Silty shale/siltstone	
		• Splintery shale	
		• Finely cleaved, banded shale, often calcareous; buff on weathering,	
		• Black Micaceous shale, pyritic, often carbonaceous and sandy	
		• Chert member	
		• Phosphate Unit	10 m
		• Chert Unit	200 m

----------Discontinuity (Submarine Diastem) Overlap---Transition at places----------			
	Transition Zone	• Argillaceous Limestone (often phosphatic interlayered with thin streaks of phosphate rock and chert, brecciated at places)	
Triassic (?)	Upper Krol Formation	• Light grey argillaceous limestone. • Purple and grey shale/slate	
		• Grey to Bluish grey dolomitic limestone and dolomites and associated shales	



Text Figure 1.2 : Geological section across Mussoorie Syncline and Lesser Himalaya after Rao et al. (1974) and Shankar (1971).

2.5.3 **Lower Tal Formation**: Chert Member is invariably the oldest unit of Tal formation, and contains phosphatic rocks towards the top. The litho-units are comprising of a thick sequence of black, bedded cherts with thin intercalations of light to dark grey shale. The black chert is often thickly bedded and is generally nodular towards its upper portion, but, below the main phosphatic zone. The phosphate content of these nodules seems to vary considerably, by and large, inversely proportional to the size; i.e., smaller the nodule higher is the phosphate content. These nodules range in diameter upto two or three centimetres and are highly

phosphatic, whereas the cherty matrix in which they are embedded is generally non–phosphatic or only mildly so. Tiny phosphatic nodules also occur in the shaly intercalations. Thin bands of black carbonaceous limestone are also found occasionally in the Chert member. Pyrite is often developed in the rocks of the Chert member**.**

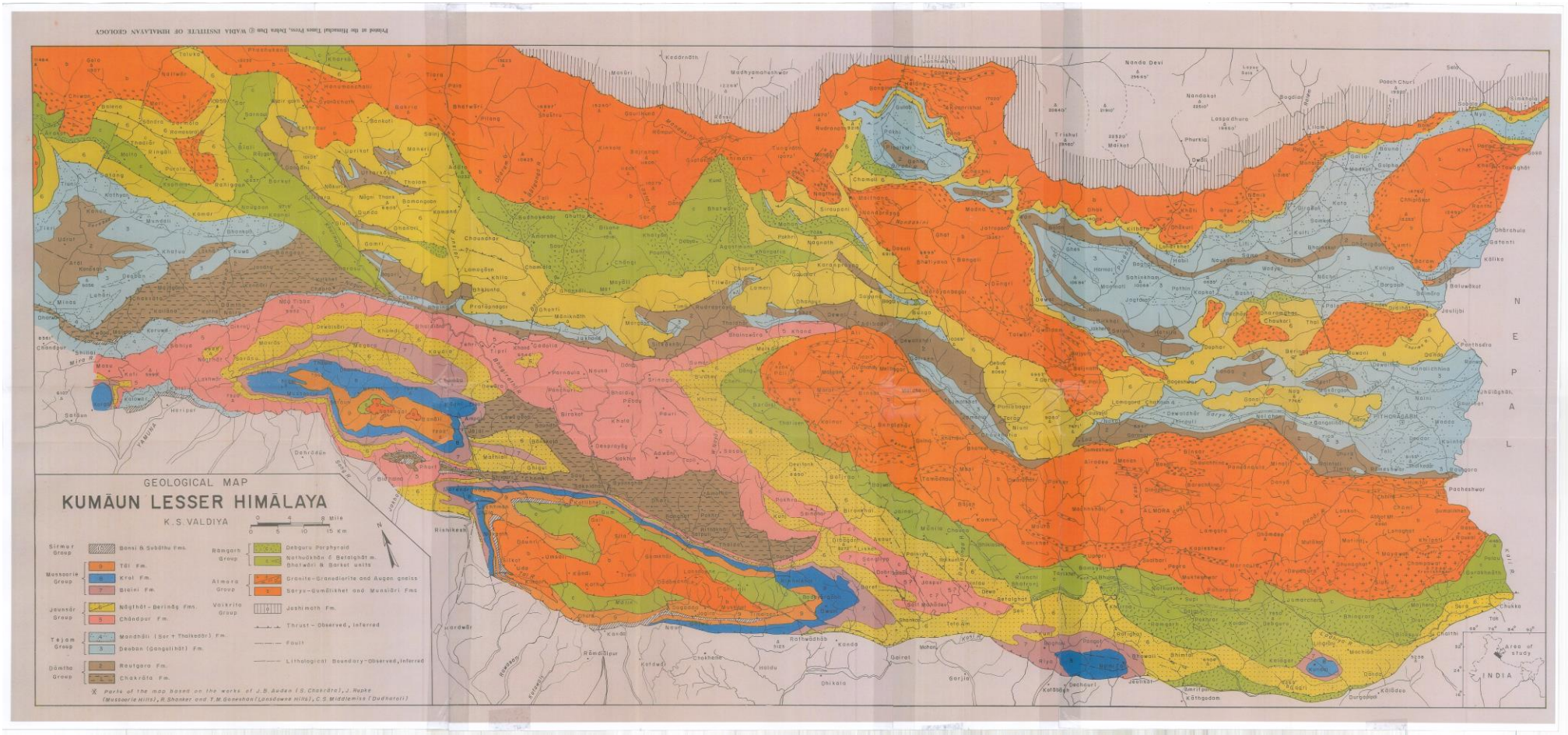
2.5.4 **Upper Tal Formation**: It is dominantly a quarzitic sequence with a thin calcareous capping and therefore has been divided into a lower quartzite member and an upper Limestone member

2.5.5 **Krol Formation:** The Krols form the oldest rock types in the area mapped normally underlying the Tal formation. Dolomitic limestone and dolomite overlain conformably by yellow weathering argillaceous limestone and calcareous shale constitute the uppermost two members of the Krol formation, mapped in this area (equivalent to the Upper Krol Limestone or Krol 'E' stage of Auden, 1935).

2.5.6 **Dolomitic Limestone and Dolomite:** These rock units occur in thickly bedded sequence sometimes massive in character. Megascopically these rocks are hard, mostly fine grained and compact with very high degree of grain contact, generally light coloured with shades varying from grayish white, cream white to bluish white on fresh surface; at times the rocks omit foetid odour on fracturing. These rocks with characteristic elephant skin weathering, show cusps and hollows, form high, rugged precipitous hills and scraps. These are highly jointed and bedding is generally obscure in more massive varieties though, occasionally and specially in the upper part, these are banded with grayish white and grayish black bands representing bedding. They are occasionally traversed by ramifying veins of calcite and/or quartz as could be seen at places in Midland and Company Khad area. These rocks show some algal structure, locally.

2.5.7 **Argillaceous Limestone:** Dolomitic limestone and dolomite are overlain by softer yellow weather argillaceous limestone and calcareous shale. The passage is marked by a prominent change in the topography with the precipitous slopes and scraps composed of former members being replaced by gently slopes in the terrain formed of the uppermost member of the Krol formation. In the latter case, exposures are few because of the soft nature of the rock. Megascopically the argillaceous limestone is comparatively non-resistant, fine grained, grayish to cream in colour on fresh surface and weathering with characteristic yellow coating on weathered surface. In general, these rocks are finely laminated as opposed to the underlying dolomitic rocks. Nodules and pockets of pyrite (limonitised at most places) are present in these rocks.

2.5.8 **Subathu Formation**: The rocks of this formation are developed, intermittently as a ring, around the three “Klippes” considered to have been brought in by the Garhwal Thrust. The exposures, are thus seen between longitude 78°15’ E –past Tonetha, Silla and Ringalgarh, and then as a small patch near Kudni in Satengal Klippe, around Darak Klippe; and south of Banali and, above Mathiangaon (in the Song valley) around Banali Klippe. It comprises olive shale, shell marl and foraminiferal limestone. Shell marl is best developed near Ringalgarh and the foraminiferal limestone (Nummulitic) is seen below Ghena.



Text Figure 1.3 : Geological Map of Kumaun Lesser Himalayas, Valdiya (1980)

2.6.0 GEOLOGY OF THE BLOCK

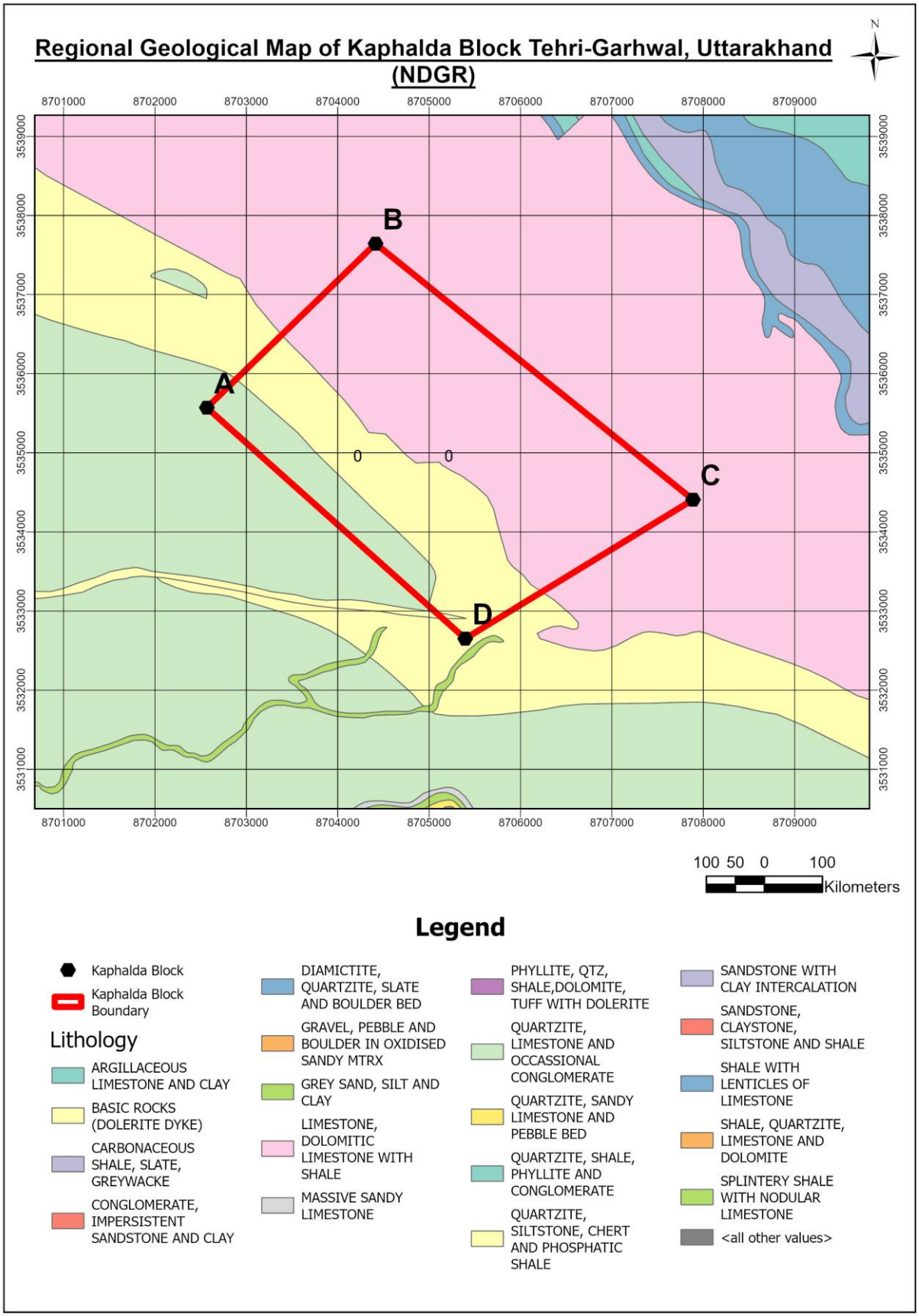
2.6.1 In the area under consideration predominantly comprises rocks of the Tal formation normally overlies the limestone sequence of the Krol formation. The local stratigraphic succession is as below (after GSI)**.**

Table- 1.3: Litho-stratigraphic classification of Block (After GSI).

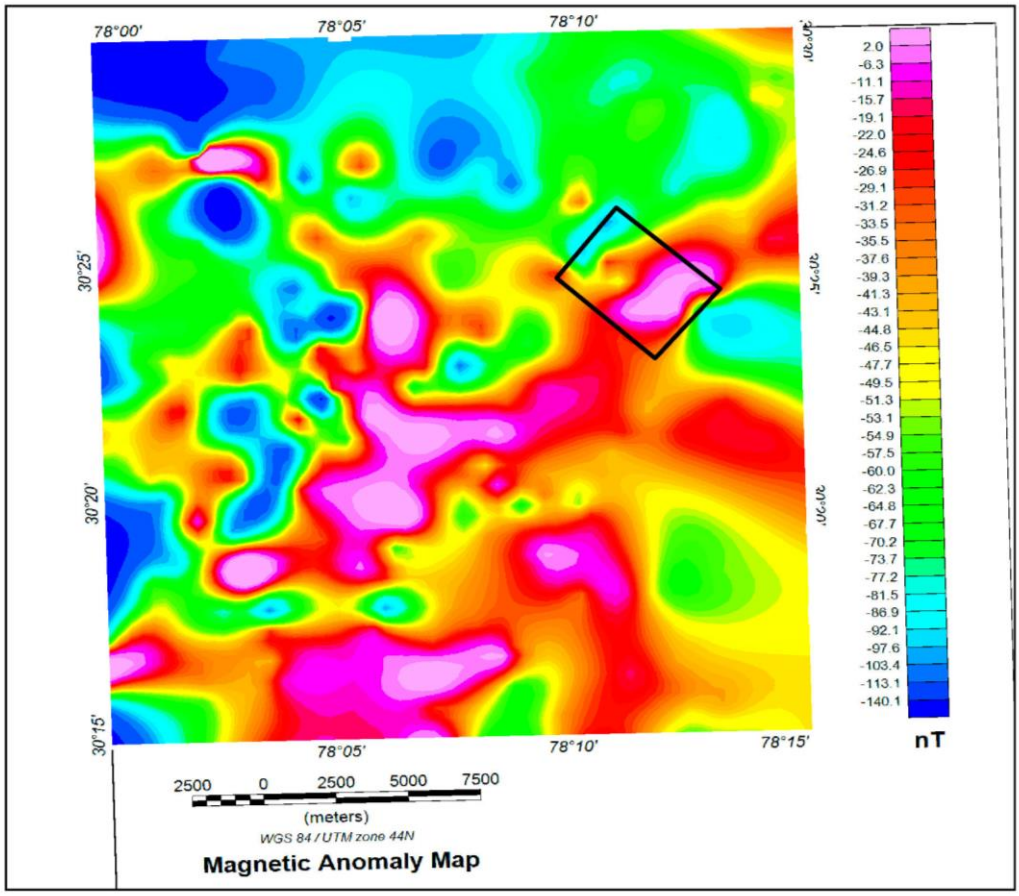
Formation	Member	Litho-unit
Lower Tal Formation	Calcareous Member	Siliceous Limestone and Shale. Banded siltstone (Sub-greywacke).
	Arenaceous Member	Grey, black Shales, Sandy, splintery, calcareous at places and associated shales.
	Argillaceous Member	Phosphorite with or without chert, the latter underlying or intercalated
	Chert Member	Bands of Phosphorite
Disconformity/ Overlap		
Transition Zone (Developed Locally)	Argillaceous Limestone (often phosphatized) interlayered with thin streak of phosphorite rock, brecciated at places.	
Krol Formation	i. Light grey to bluish grey argillaceous limestone and associated grey pyretic shales and pink calcareous shales. ii. Grey dolomitic limestone and associated shales.	

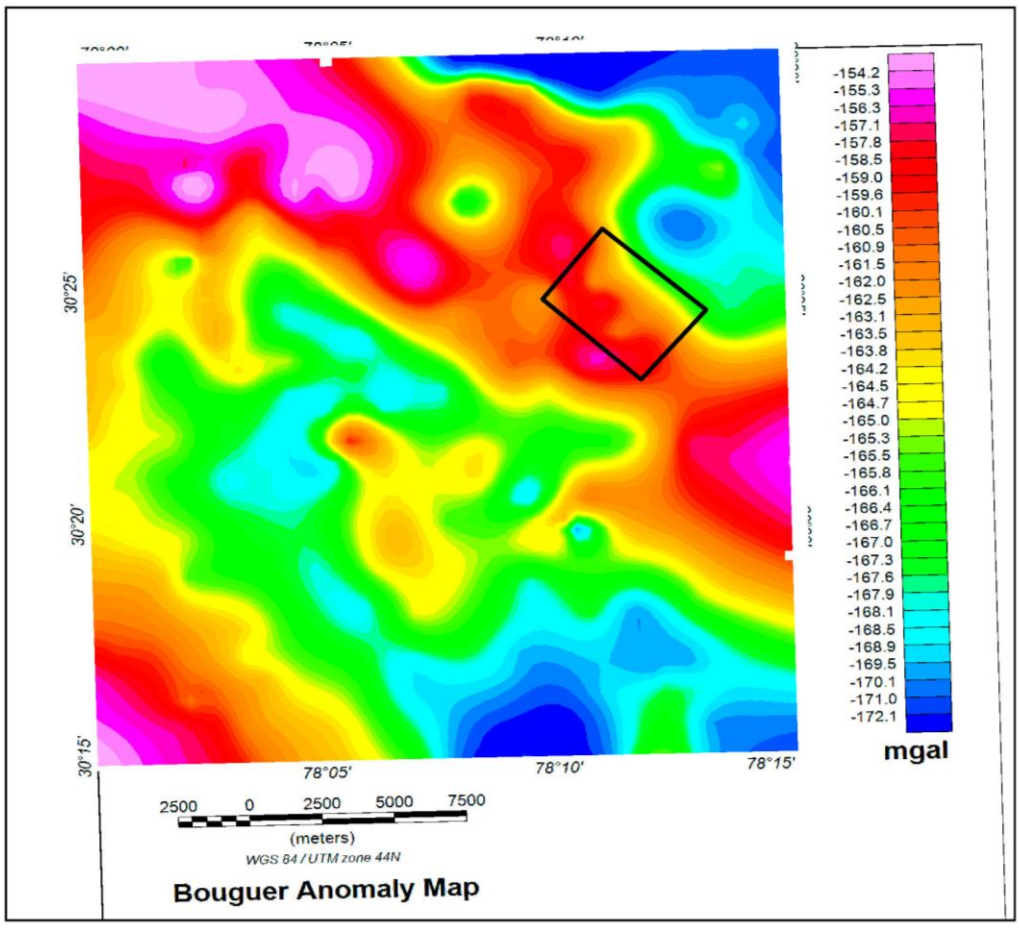
2.7.0 Geophysical Data

2.7.1 The Magnetic and Bouguer anomaly map shown in text figure 1.5. High magnetic anomaly has been observed at the central to southern part of the block, whereas Bouguer anomaly is gradually decreasing from western to eastern side of the block.



Text Figure 1.4 : Geological Map of Kaphalda Block at 1:50,000 (NGDR).





Text Figure 1.5 : Magnetic and Bouguer Anomaly Map of Kaphalda Block at 1:50,000 (NGDR).

2.8.0 PREVIOUS WORK / BACKGROUND INFORMATION

2.8.1 Earliest record of work on the Tal rocks, though not formally named, is found in a paper entitled “Geological Sketch of Musuri and Landour in the Himalaya” by Fisher (1832). Fisher recognized the difference between the Tal rocks of Landour and the Krol limestone of Mussoorie. Later on, Medlicott (1864) did the mapping between the Ravi and Ganga rivers. He described and named the Tal rocks in the Tal Valley, east of the Ganga. In 1882, R.D. Oldham traversed from Almora to Mussoorie. Mapping of Middlemiss (1887) and Auden (1934–35) revealed the existence of Tal beds in four separate basins. Although the occurrence of phosphatic rocks in Midlands, Mussoorie was first reported by King (1885) the presence of phosphatic nodules in shales was discovered much earlier by Rev. J. Parson during the course of his search for fossils. The detailed geological background of the area was given by Auden (1934 and 1935), who mapped the Krol belt to Himachal Pradesh and Uttar Pradesh. Auden suggested the following sequence in his progress report for the field season 1934–35.

2.8.2 H.N. Singh (1960-61) mapped the area around Mussoorie and examined the occurrences of phosphatic nodules and rocks. He subdivided the Tal formation into three units viz. Lower, Middle and Upper Tals. His Middle Tal corresponds to the banded shales/slates/greywackes sequence of Auden. He also indicated the occurrence of phosphatic rocks within the black shale and cherts of the Lower Tals. Similarly, a part of Lower Tal–Krol limestone contact zone in the adjoining area of Sirmur district, H.P. was examined with initial success (Dass, 1961). The attempt of exploring the phosphate potentialities of the Lower Tal rocks was continued in the following seasons by R.N. Srivastava and K.N. Ali not only in parts of Mussoorie Syncline, but also in parts of the Srivastava & Roy, 1966, Srivastava and Ali.). Srivastava also favoured the three-fold classification of Tal Formation as suggested by Singh. Thus, the preliminary work of Singh and Srivastava, suggesting the possibility of the entire Lower Tal black shale-chert association overlying the Krol limestone being the only horizon for the occurrence of phosphorite, culminated in the present intensified exploration programme for phosphorite, started in April, 1966. However, the visit of Dr. R. P. Sheldon of U.S.G.S. in March, 1966 to the country and the discovery of the Birmania occurrence in Rajasthan based on the data furnished by the O.N.G.C. gave a great fillip to the programme of search for inland deposits of phosphate in the country. Accordingly, the search for phosphate in Mussoorie area was given a priority of attention resulting in progressive intensification of activities over the entire Mussoorie Syncline. The search for phosphate in the Lower Tal–Upper Krol contacts in the adjoining Sirmur district, H.P. and Tehri and Pauri–Garhwal districts, U.P. met with initial success.

2.8.3 The results of the investigations carried out by GSI in the Mussoorie area during the period April, 1966 to February, 1971 (May 1971). The investigation had been divided into various stages which included,

2.8.4 **Stage I** Reconnaissance mapping, followed by structural mapping on scale 1**:**31,680, in order to single out the potential phosphatic horizons and promising areas for detailed survey and prospecting.

2.8.5 **Stage II** Detailed and large scale geologic–cum–topographic mapping (with the help of plane-table and tele-scopic alidade) of promising areas and deposits along with prospecting by pitting, trenching, sampling and analysis to assess the reserves, grade and potentialities of the individual deposits.

2.8.6 **Stage III** Based on the results of the above surface exploration, a programme of sub-surface exploration by drilling was taken up in Nagani, Kimoi, Masrana, Maldevta, Durmala, Paritibba– Chamasari and Bhusti-Jalikhal deposits. The programme of drilling had to be periodically reviewed based on the gradually, emerging picture of the subsurface behaviour, grade, and possible reserves of the phosphatic zones met with at depths. Drilling was intensified in Maldevta (West), Durmala and later on to Bhusti areas, based on available information. A programme of exploratory mining was also taken up in selected blocks, particularly in Maldevta, Durmala and in Bhusti-Jalikhal areas. Efforts, in this direction, were mainly aimed at collection of fresh/unweathered bulk samples of phosphorite from depths for beneficiation and other utilization tests. Apart from these, a number of pits, short inclines and adits were also driven in Masrana, Chamasari and Maldevta areas with a view to ascertaining the depth of weathering and nature of variation in grade of phosphorite from surface down-dip.

2.8.7 From an assessment of the data collected during the above investigation including large scale geological mapping, pitting trenching, sampling and analyses in the various blocks, it could be seen that phosphate rock and phosphorites (i.e., phosphate rock with more than 15% P_2O_5) have been located in almost all the blocks in the Mussoorie Syncline. However, these bands vary in thickness, lateral extent and in chemical grade. Due to operational difficulties, particularly the problems posed by thick cover of superincumbent rocks, soil debris and terrain conditions, it has not been possible to establish precisely the persistence or otherwise of the phosphatic zone along strike in some of the blocks of which special mention needs be made of the Nagani block and the Bagi–Mathiangaon block.

2.8.8 A broad picture however has emerged about the general mode of occurrence of comparatively persistent and generally better grade phosphate occurring in bands having thickness of more

than one meter which is considered to be the minimum minable thickness. It is also seen that the phosphate band as seen in the different block, generally improves towards SE in thickness, grade and strike continuity. Thus, from Toneta on the north–west where the phosphate band is 0.45 m to 4.58 m. in thickness with around 10.0% P_2O_5 content there is general improvement noticed in Kimoi–Masrana–Durmala and Bhusti–Jalikhal–Mathiangaon blocks on the northern limb and in Paritibba and Chamasari and Maldevta area on the southern limb (including the digitated limbs of the Mussoorie Syncline i.e. the Castle Hill Syncline) towards the southeast.

2.8.9 Again, in the south–eastern part of the Mussoorie Syncline, phosphate bands located in the various blocks are generally of lesser extent and have given evidences of rapid changes in thickness and discontinuity along strike where effects of sedimentary overlap, and tectonic elimination, apart from original sedimentary pinching and swelling of phosphate bands have been noticed. It is also clear from the available information that the phosphate bands, though predominantly present in the Chert member of the Lower Tal formation, phosphatisation had no doubt also a feature noticeable in the Upper horizons of the underlying Krol formation as seen in Nagani, Chaunpa–Kumali blocks.

2.8.10 It needs be mentioned here that the matrix of the phosphorite, being also formed of carbonate minerals, the samples collected from surface trenches have at times yielded higher content of P_2O_5 due to removal of carbonate during the process of weathering near surface. Thus, the range of P_2O_5 given in the above table would not be taken to be the grade of the material likely to be met with at depth i.e., below the zone of weathering. It has already been indicated that in some cases a perceptible downward change in grade has been noticed in phosphate bands when sampled along exposure downdip. Keeping this in view, and also for the purpose of exploring the possibilities of economic exploitation of the phosphorites of these blocks, it was considered necessary to undertake a programme of subsurface exploration through drilling and exploratory mining. The drilling programme aimed at collection of information regarding the nature and behaviour of the phosphate zone at depth.

2.8.11 The objective of exploratory mining was to collect bulk samples of fresh, unweathered phosphorite for beneficiation and other tests to assess eventual utilization. For subsurface exploration, priority was given to the following blocks: (1) Maldevta West, Bhusti, Masrana, and Durmala. In view of the structural complexities observed in the Kimoi and Nagani areas, a few exploratory structural holes were drilled in these three regions.

2.9.0 OBSERVATION AND RECOMMENDATIONS OF PREVIOUS WORK

2.9.1 The present area is widely recognized for its significant phosphorite occurrences, with the Geological Survey of India (GSI) conducting extensive prospecting in the Mussoorie region

between April 1966 and February 1971. Large-scale geological mapping (Lsm), pitting, trenching, sampling, and analysis, of the area revealed that phosphate rock and phosphorites (with P_2O_5 content exceeding 15%) are present in almost all blocks within the Mussoorie Syncline. However, these phosphate bands are of variable thickness, lateral extent, and chemical grade. Due to operational difficulties, such as thick overburden, soil debris, and difficult terrain, hindered precise delineation of phosphatic zones along strike in certain blocks, notably the Nagani and Bagi-Mathiangaon blocks. Despite these limitations, a broad understanding of the deposits emerged, about the general mode of occurrence of comparatively persistent and generally better grade phosphate occurring in bands having thickness of more than one meter which is considered to be the minimum minable thickness. Is has seen the phosphate bands generally improve in thickness, grade, and strike continuity towards the SE. For instance, bands in Toneta on the northwestern limb vary between 0.45 m and 4.58 m in thickness with approximately 10.0% P_2O_5 content. In contrast, southeastward blocks, such as Kimoi, Masrana, Durmala, Bhusti-Jalikhal, and Mathiangaon on the northern limb, and Paritibba, Chamasari, and Maldevta on the southern limb (including the Castle Hill Syncline), exhibit improved grades and continuity. However, in the southeastern part of the syncline, phosphate bands are more discontinuous and exhibit rapid changes in thickness due to sedimentary overlap, tectonic elimination, and original depositional variations.

2.9.2 The phosphate occurrences are predominantly associated with the chert member of the Lower Tal Formation. Prophetization has been observed in the upper horizons of the underlying Krol Formation in blocks such as Nagani and Chaunpa-Kumali. The systematic data collection and exploration, has provided insights into the strike length, thickness, P_2O_5% content range, and weighted average grades of the phosphate bands in each area of Mussorie Syncline is given in the table below**:**

Table- 1.4: Phosphate Bands of Mussoorie Syncline

Sl. No.	Block	Strike length of Phosphate band	Thickness	Range of Weighted average P_2O_5 % Content
1.	Toneta-Kaphulti	2 km	0.60 m	15%
2.	Kolti	3.2 km	0.77 -1.04 m	10-12.7%
3.	Kimoi	1.0 km	0.50-4.48 m	11-29.3%
4.	Masrana	1.4 km	0.20-8.58 m	11-33%
5.	Durmala	1.52 km	3.0-9.00 m	23.32 %
6.	Silgaon-Bhusti	2.8 km	0.12 -0.65 m	33.7 -36.9%
7.	Bhusti-Jhamtialgaon	3.1 km	0.46-2.55 m	26.4-35.5%

8.	**Bhusti-Jalikhal**	**1.32 km**	**1.70-6.28 m**	**20.5-32.3%**
9.	**Bagi-Mathiangoan**	**2.72 km**	**0.45-2.95 m**	**22.8-32.3%**
10	**Nagani**	**1.25 km**	**Few cm- 2,45 m**	**13.9-19.2%**
11	**Chaunpa-Kumali**	**1.2 km**	**0.10-2.4 m**	**15-34.0%**
12	**Bemunda**	**0.75 km**	**0.15 -0.90 m**	**3-21%**
13	**Malas**	**1.7 km**	**0.90-2.40 m**	**7-11%**
14	**Chiphaldi**	**2.36 km**	**0.20 – 2.00 m**	**21.8-36%**
15	**Dubra**	**2.5 km**	**0.13-2.04 m**	**17.2-31.1%**
16	**Mathet**	**2.5 km**	**0.60-1.20 m**	**20.4-32.5%**
17	**Maldeota**	**1.30 km**	**0.45-7.8 m**	**15-30.9%**
18	**Chamasari (Part of northern limb of minor syncline)**	**1.1 km**	**0.55-3.92 m**	**11-27.5%**
19	**Paritibba (part of Block 'D' northern limb of minor syncline)**	**1.10 km**	**1.2-7.2 m**	**15-31.2%**
20	**Dhobighat-Manjhkhet**	**2.00 km**	**Traces-1.70 m**	**22-30.0%**
21	**Paritibba-Chamasari Block (Southern limb of minor syncline)**	**1.80 km**	**1.00-3.5 m**	**14-31%**

2.10.0 JUSTIFICATION

2.10.1 The proposed Kaphalda Block, located within the renowned Mussoorie Syncline, lies between significant phosphorite deposits such as Kimoi, Masrana, Durmala, Silagoan-Bhusti, and Bhusti-Jhamthiogaon, previously explored by the Geological Survey of India (GSI). Among these, the Durmala Block is recognized as one of the best-developed phosphorite zones, alongside the Maldevta phosphate band in the syncline. The phosphate unit in these areas occurs towards the upper part of the phosphorite bed, conformable with black cherts and overlying shales of the Argillaceous member of the Tal Formation. However, lateral intertangling relationships between the units have been observed. The shales are phosphatic, with the chert member situated above the black chert and associated shales.

2.10.2 In the Kaphalda Block, while the black chert bed is not visibly developed or may be concealed beneath the surface, literature indicates that the phosphate unit directly overlies the Krol limestone and dolomite in adjacent areas such as the Durmala Block. The phosphate unit in the Durmala Block varies in thickness from 0.40 m to nearly 4.0 m, with phosphate grades ranging from 17% P_2O_5 to 30% P_2O_5 in certain areas. Durmala block, situated on the northern limb of the Mussoorie Syncline between Masrana and Bhusti, features an ore body traced over a strike length of approximately 5.7 km from Masrana to Bhusti, occurring on both sides of the ridge at altitudes between 1650 MRL and 1950 MRL.

2.10.3 The upper phosphate band and the intercalated chert and shale diminish in thickness and gradually interfinger with shale. However, this phosphatic sequence of the Lower Tal Formation and associated shale was not exposed in the Kaphalda Block, as noted during geological mapping by PPCL at a scale of 1:63,363.

2.10.4 Given the high grade of phosphorite in adjacent blocks and the geological continuity of the formations and exploration history of the proposed area is not available. Therefore, it is the need of the hour to initiate the systematic exploration to established the continuity of phosphorite deposits.

2.10.5 **OBJECTIVE:**

2.10.6 The exploration is proposed with the following objectives:

a) Preparation of Geological map at 1:12,500 Scale.
b) To collect surface (Bedrock) samples for analyses of Phosphate and associated minerals.
c) To prove the mineralized zones by bedrock sampling for the outcrops, pitting, trenching and scout drilling. Scout drilling holes to be planned at convenient intervals, in the blocks exposing sections of Krol-Tal contact, cherts, phosphate rock and the overlying shales in order to measure the thickness of phosphatic horizons and associated rocks and to study their lateral and vertical relationship.
d) To upgrade the block in G-3 and facilitate the state govt. for auctioning of the block.

2.11.0 PROPOSED EXPLORATION SCHEME

2.11.1 In accordance to the objective set for Kaphalda Block, the following scheme of exploration has been formulated. The details of different activities to be carried out are presented in subsequent paragraphs.

2.11.2 **GEOLOGICAL MAP**

2.11.3 The geological map (1:12,500 scale) will be prepared based on structural data, surface samples, drill core-log etc. carried out during G-4 stage. This map will be used as base map for future work.

2.11.4 **Surface samples (bedrock samples):**

2.11.5 During the large-scale mapping 100 nos. of bedrock samples will be collected from phosphorite bearing rocks. To delineate the potential phosphate bearing chert - black shale association of Lower Tal Formation.

2.11.6 **DRILLING**

2.11.7 After surface geological mapping, the possible extensions of the phosphate zones will be identified based on the known horizons of adjacent mines. To evaluate the potential of the mineralized zones along strike and dip, a few scout boreholes totaling 500 meters of drilling will be conducted. This will target shallow-level intersections to confirm the actual continuity of the phosphatic horizons.

2.11.8 **LABORATORY STUDIES**

2.11.9 **Chemical Analysis:**

a) **Primary Samples**- All the primary (100 Nos) and check samples (10 Nos. around 10% external samples) will be analyzed from NABL accredited laboratory as external check samples for analysis of 10 radicals i.e., P_2O_5%, CaO%, MgO%, Na2O%, K2O%, MnO%, SiO_2%, Al_2O_3%, Fe_2O_3% & LOI%.

b) **ICP-MS studies** will be done on 30 nos of samples to know the presence of trace elements and REE.

c) **XRD studies** will be done on 30 nos of samples to know the presence of mineral phases.

2.11.10 **Petrological Studies:** Petrological studies will be done on around 10 nos of rock specimen.

2.11.11 **Mineragraphic Studies:** Mineragraphic studies will be done on around 10 nos of rock specimen for REEs and associated minerals.

2.12.0 QUANTUM OF WORK

The details of quantum of work block in Kaphalda Block have been furnished below:

Table No 1.5: Summarized Details of the proposed quantum of work

Proposed Nature of Quantum for Reconnaissance Survey (G-4) for Phosphorite in Kaphalda Block, District: Dehradun, Uttarakhand			
Sl. No.	**Item of Work**	**Unit**	**Proposed Quantum of work**

Proposed Nature of Quantum for Reconnaissance Survey (G-4) for Phosphorite in Kaphalda Block, District: Dehradun, Uttarakhand			
1	**Large Scale Geological Mapping** (on 1:12,500 Scale)	sq. km	16.68
2	**Geochemical Sampling**		
	Surface sampling	Nos.	100
3	**Pitting and Trenching**		
	Trenching	Cu.m	100
3	**Exploratory Drilling**		
	a) Drilling (core) Scout drilling	Meters	500
	b) Geological Logging	Meters	500
	c) Borehole core samples (primary)	Meters	100
4	**Laboratory Studies**		
	A. Surface samples		
	a) Chemical Analysis; Primary for 10 radicals i.e., P_2O_5%, CaO%, MgO%, Na2O%, K2O%, MnO%, SiO_2%, Al_2O_3%, Fe_2O_3% & LOI%.	Nos.	100
	b) External Check sample (10 % of Primary samples) for analysis of 10 radicals i.e., P_2O_5%, CaO%, MgO%, Na2O%, K2O%, MnO%, SiO_2%, Al_2O_3%, Fe_2O_3% & LOI%.	Nos.	10
	c) IC-PMS; 34 Elemental Study - REE associated Trace Elements (Sn, Hf, Nb, Ta, U, Th, Be, Ba, Ge, As, Rb, Sr, W, Mo, Ti, Zr, Cs, Y, Sc, Pb, Zn)	Nos.	30
	B. Drill Core samples		
	a) Chemical Analysis; Primary for 10 radicals i.e., P_2O_5%, CaO%, MgO%, Na2O%, K2O%, MnO%, SiO_2%, Al_2O_3%, Fe_2O_3% & LOI%.	Nos.	100
	b) External Check sample (10 % of Primary samples)	Nos.	10
5	**Physical Studies**		
	a) XRD studies	Nos	30
	b) Petrographic Studies	Nos	10
	c) Mineragraphic Studies	Nos	10
7	**Report Preparation (5 Hard copies with a soft copy)**	Nos.	01

7.0.0 BREAK-UP OF EXPENDITURE

7.1.0 Tentative Cost has been estimated based on Schedule of Charges (SoC) of projects funded by National Mineral Exploration Trust (NMET) w.e.f. OM No. 61/1/2018/NMET dated 31st March 2020. The total estimated cost is **Rs. 391.19 (say, in lakhs).** The summary of tentative cost estimates for Reconnaissance Survey (G-4 Level) is given in **Table – 1.6.** Detailed cost sheet for proposed Reconnaissance Survey (G-4) for Phosphate, REE & associated minerals is given as **Annexure No. I.**

Table-1.6: Summary of Cost Estimates for Reconnaissance Survey (G-4 Level) Exploration

Sl. No.	Item	Total Estimated Cost (Rs.)
1	Geological Work	83,61,224.80
2	Pitting & Trenching	12,73,000.00
3	Drilling	2,03,64,650.00
4	**Sub total**	**2,99,98,874.80**
5	Geologist at HQ	**2,70,000.00**
6	Laboratory Studies	14,02,390.00
7	**Sub total**	**16,72,390.00**
9	Report	9,50,137.94
10	Peer Review	30,000.00
11	Proposal Preparation	5,00,000.00
12	**Sub total**	**14,80,137.94**
13	**Total**	**3,31,51,402.74**
14	GST (18%)	59,67,252.49
Total cost including 18% GST		**3,91,18,655.24**
SAY, in Lakhs		**391.19**

7.2.0 TIMELINE

The proposed exploration programme envisages geological mapping, surface sampling, drilling, sample preparation and laboratory studies, which will be completed within 06 months, geological report preparation with peer review will take 06 months. Therefore, a total of **12 months** is planned for completion of the entire proposed programme in view of tough Himalayan hilly and rugged terrain and other climatic difficulties. Tentative Time schedule/action plan for proposed Reconnaissance Survey (G-4) for Phosphorite is given in **Annexure No. II.**

REFERENCES:

1. Bhukosh website, Hosted by GSI, Ministry of mines, Government of India.
2. Indian Mineral Yearbook 2019 (Part-III: Mineral Reviews) 58th Edition, Apatite and Rock Phosphate, Government of India Ministry of Mines, Indian Bureau of Mines.
3. NGDR website, Hosted by GSI, Ministry of mines, Government of India.
4. Officers of Geological Survey of India (May 1971): Report on the investigation of Phosphorite in parts of the Mussoorie Syncline, Districts Dehradun and Tehri, Uttar Pradesh (April, 1966 to February, 1971).

LIST OF PLATES

1. Plate-I: Location map of Kaphalda Block, District-Dehradun, Uttarakhand.
2. Plate-II: Regional Geological map showing proposed Block (Source: NGDR).
3. Plate-III: Regional Geophysical map of Magnetic and Bouguer anomalies showing proposed Block (Source: NGDR).

Cost Estimate of Reconnaissance Survey (G-4 Stage Exploration) For Phosphate, REE & associated Trace elements in Kaphalda Block, Districts: Dehradun & Tehri Garhwal, State: Uttarakhand
Total Area - 16.68 sq km; Completion Time -12 Months, Review after 6th Month, Drilling 500 m, BH 5 Nos

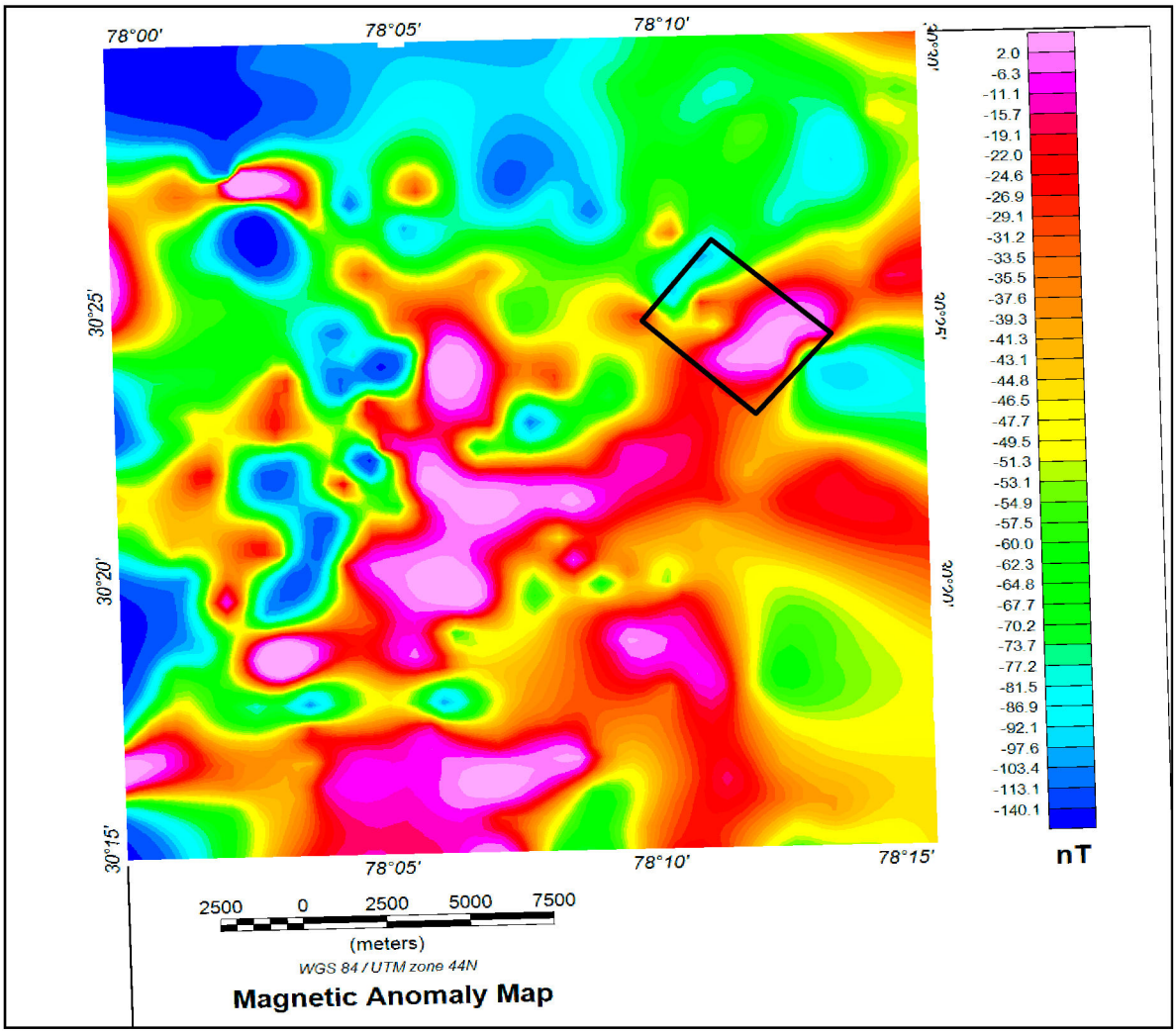
S.N	Item of Work	Unit	Rates as per NMET SoC 2020-21			Estimated Cost of the		Remarks
			SoC-Item -Sl No.	Rates as per SoC	Rate@3.35 times for Himalya region	Qty.	Total Amount (Rs)	
A	**GEOLOGICAL WORK**							
a	Charges for Geologist at field for Large scale mapping (1: 12,500), Surface sampling and drilling	day	1.2	11,000	36,850	180	66,33,000	
b	Labour Charges for Geologist;	day	5.7	526	1,762	360	6,34,356	Amount will be reimburse as per the notified rates by the Central Labour Commissioner or respective State Govt. whichever is higher
c	Charges for Sampler for geochemical, channel samples	one sampler per day	1.5.2	5,100	17,085	32	5,46,720	
d	Labour Charges for Sampling Work; Base rate - Rs. 526/ per day	day	5.7	526	1,762	128	2,25,549	Amount will be reimburse as per the notified rates by the Central Labour Commissioner or respective State Govt. whichever is higher
e	DGPS Survey for BH fixation & RL determination	Per Point of observation	1.6.2	19200	64,320	5	3,21,600	5 Core Drill BHs
	Sub-Total A				-		**83,61,225**	
B	**PITTING AND TRENCHING**				-			
a	TRENCHING	Cu m	2.1.2	3,800	12,730	100	**12,73,000**	
C	**DRILLING**				-		-	
1	Core Drilling up to depth of 300 m - Medium hard Rock	m	2.2.1.3	10,100	33,835	500	1,69,17,500	
2	Land / Crop Compensation (in case the BH falls in agricultural Land)	per BH	5.6	20,000	67,000	5	3,35,000	
3	Construction of concrete Pillar (12"x12"x30")	per borehole	2.2.7a	2,000	6,700	5	33,500	
4	Transportation of Drill Rig & Truck associated per drill	Km	2.2.8	36	121	3,000	3,61,800	Approx 3000 km to & fro from Nagpur/ Rig
5	Monthly Accomodation Charges for drilling Camp (up to 2 Rigs)	month	2.2.9	50,000	1,67,500	3	5,02,500	
6	Drilling Camp Setting Cost	Nos	2.2.9a	2,50,000	8,37,500	1	8,37,500	
7	Drilling Camp Winding up Cost	Nos	2.2.9b	2,50,000	8,37,500	1	8,37,500	
8	Road Making (Hilly Terrain)	Km	2.2.10b	32,200	1,07,870	5	5,39,350	
	Sub-Total C						**2,03,64,650**	
D	**Sub Total A to C**						**2,99,98,875**	
E	**Charges for Geologist at HQ for data processing**	**day**	**1.3**	**9,000**		**30**	**2,70,000**	
F	**LABORATORY STUDIES**							
1	**Chemical Analysis**							
i)	**Primary Samples Surface + BH Core Samples**							
	Phospharite (P2O5%, CaO%, MgO%, Na2O%, K2O%, MnO%, SiO2%, Al2O3%, Fe2O3% & LOI%.) by XRF	Nos	4.1.14	4,200		200	8,40,000	Surface samples-100, BH Core-100
ii)	**External check samples (10%)**							
	Phospharite (P2O5%, CaO%, MgO%, MnO%, SiO2%, Al2O3%, Fe2O3% & LOI%.) by XRF	Nos	4.1.14	4,200		20	84,000	
iii)	**REEs & Trace Elements Ananlysis by ICPMS**							
	REEs and associated Trace Elements Ananlysis by ICPMS	Nos	4.1.15a	7,731		30	2,31,930	REE & associated trace elements -30
2	**Physical & Petrological Stusies**							
i)	Preparation of thin section	Nos	4.3.1	2,353		10	23,530	
ii)	Complete petrographic study report	Nos	4.3.4	4,232		10	42,320	
iii)	Preparation of polish section	Nos	4.3.2	1,549		10	15,490	
iv)	Complete mineragraphic study report	Nos	4.3.4	4,232		10	42,320	
v)	Digital Photographs	Nos	4.3.7	280		10	2,800	
vi)	XRD Study	Nos	4.5.1	4,000		30	1,20,000	
	Sub-Total -F						**14,02,390**	
G	**Total D+E+F**						**3,16,71,265**	
H	**Geological Report Preparation**	**5 Hard copies with a soft copy**	**5.2**	For the projects having cost exceding Rs 300 Lakh, A minimum of Rs 9.0 Lakh or 3% of the work whichever more and Rs 10000/- per each additional copy			**9,50,138**	EA has to submit the final Geological Report in Hard Copies (5 Nos) and the soft copy to NMET.
I	**Peer review Charges**		**As per EC decision**				**30,000**	
J	**Preparation of Exploration Proposal (5 Hard copies with a soft copy)**	**5 Hard copies with a soft copy**	**5.1**	**2% of the Cost or Rs. 5.00 Lakhs whichever is lower**			**5,00,000**	EA has to submit the Hard Copies and the soft copy of the final proposal along with Maps and Plan as suggested by the TCC-NMET in its meeting while clearing the proposal.
K	**Total Estimated Cost without GST**						**3,31,51,403**	
L	**Provision for GST (18% of L)**	**%**					**59,67,252**	GST will be reimburse as per actual and as per notified prescribed rate
M	**Total Estimated Cost with GST**						**3,91,18,655**	
						or Say Rs. , In Lakhs:	***391.19***	
Note:								
$	Trenching/Pitting dimensions are tentative may vary depending upon the geology and field conditions							
#	2nd level of work shall be carried out after review of 1st level work i.e. Geological mapping, geochemical sampling and analysis							

Note - If any part of the project is outsourced, the amount will be reimbursed as per the Paragraph 3 of NMET SoC and Item no. 6 of NMET SoC. In case of execusion of the project by NEA on its own, a Certifiate regarding non

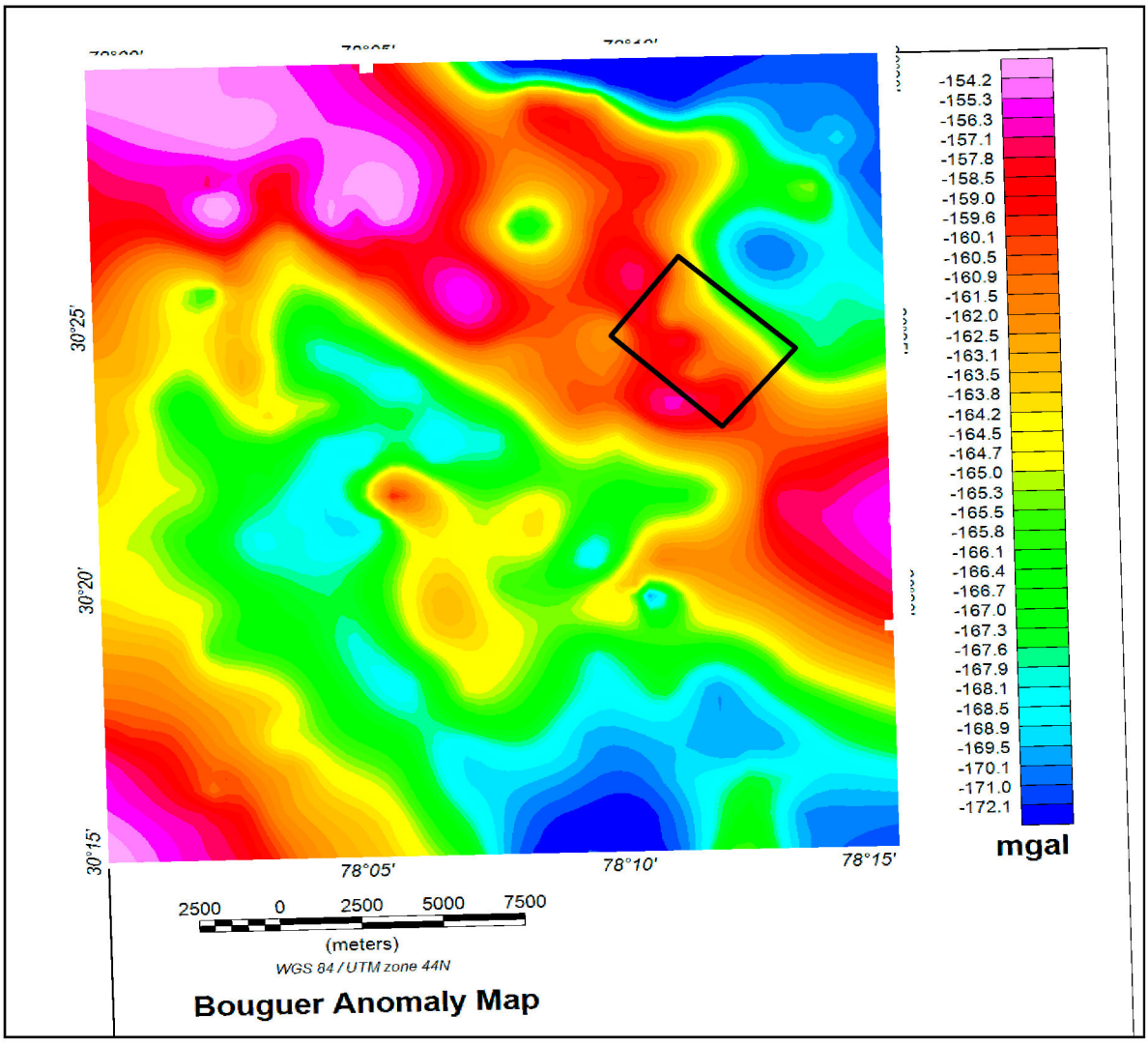
Time Schedule for Reconnaissance Survey (G-4 Stage Exploration) For Phosphate, REEs and associated trace eelements in Kaphalda Block, Districts: Dehradun & Tehri Garhwal, State: Uttarakhand

		1	2	3	4	5	6		7	8	9	10	11	12
1	Camp Setting													
2	Geological Party Days													
3	Sampling													
4	Sample Preparation													
5	Laboratory Studies													
6	DGPS survey /BH Fixation							Review						
7	Core Dilling													
8	Core Sample Preparation													
9	Camp Winding													
10	Geologist Party days, HQ													
11	Geological Report Writing													
12	Peer Review													

* Commencement of project will be reckoned from the day the exploration acreage is available along with all statutory clearances
* Time loss on account of monsoon/agricultural activity/forest clearance/local law and order problems will be addition to above time line

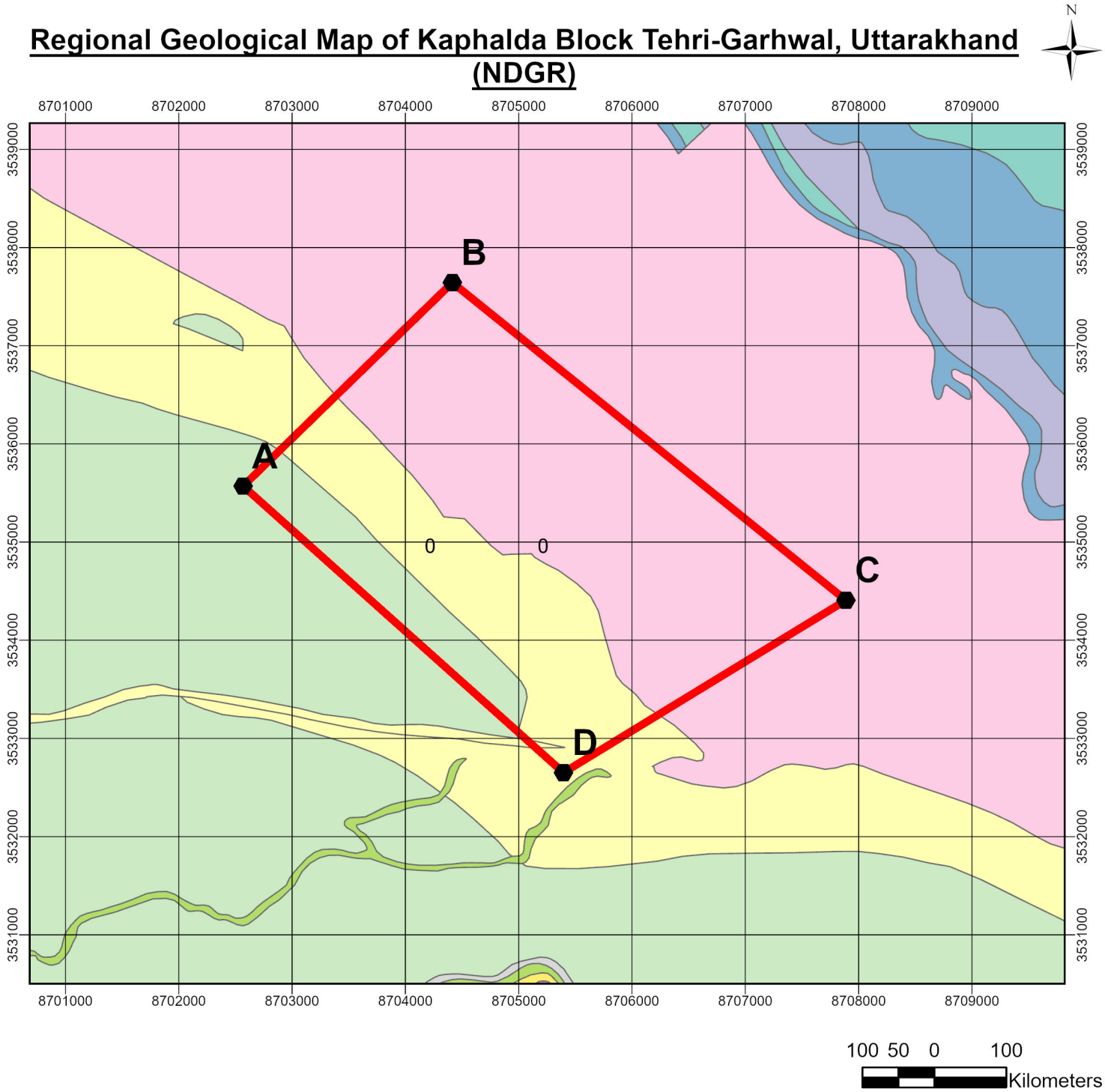


Magnetic Anomaly Map



Bouguer Anomaly Map

Regional Geological Map of Kaphalda Block Tehri-Garhwal, Uttarakhand (NDGR)



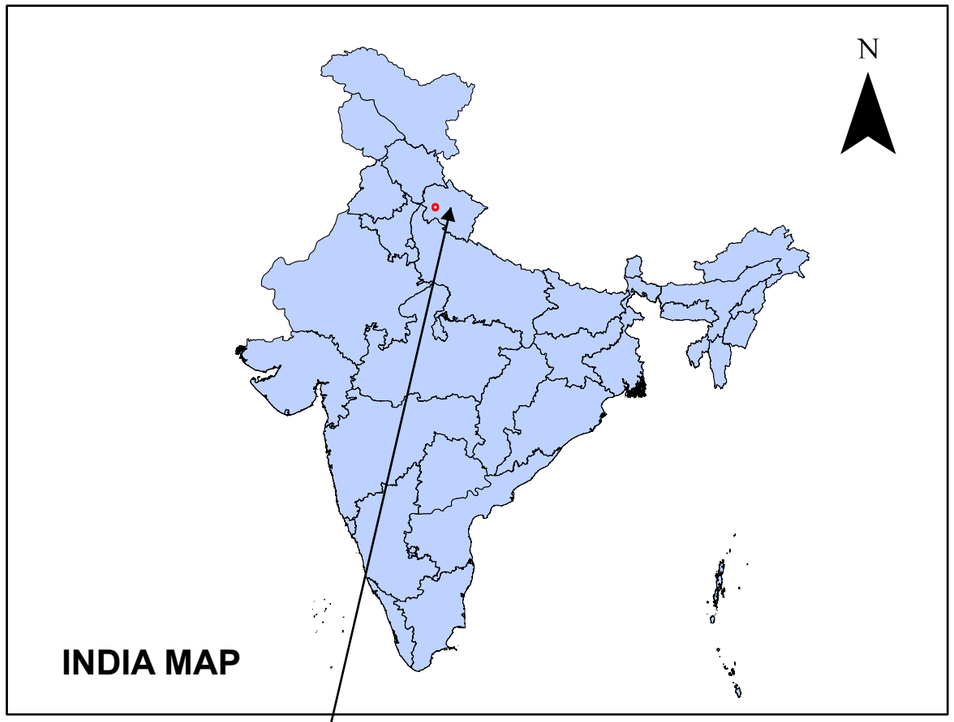
Legend

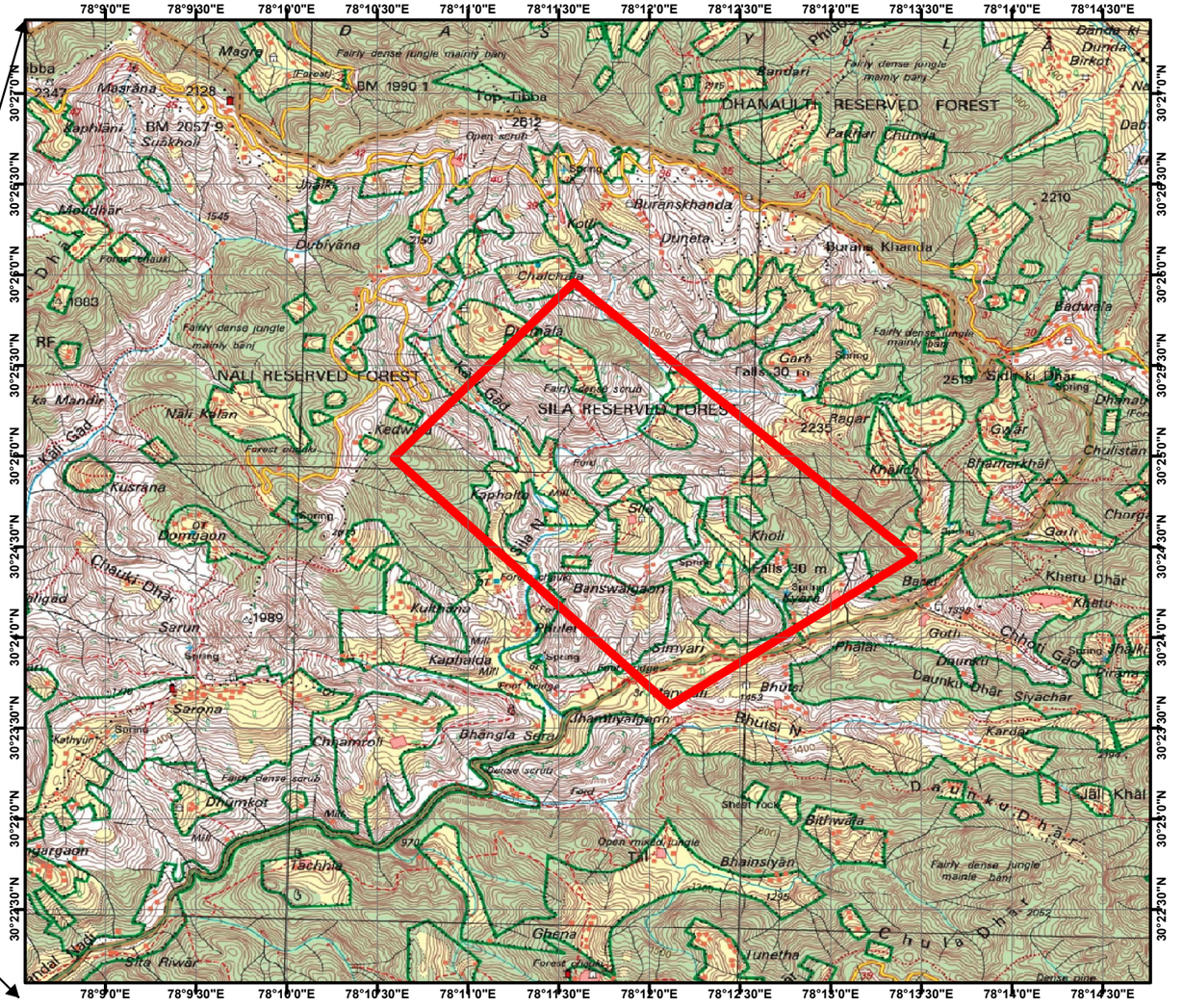
- Kaphalda Block
- Kaphalda Block Boundary

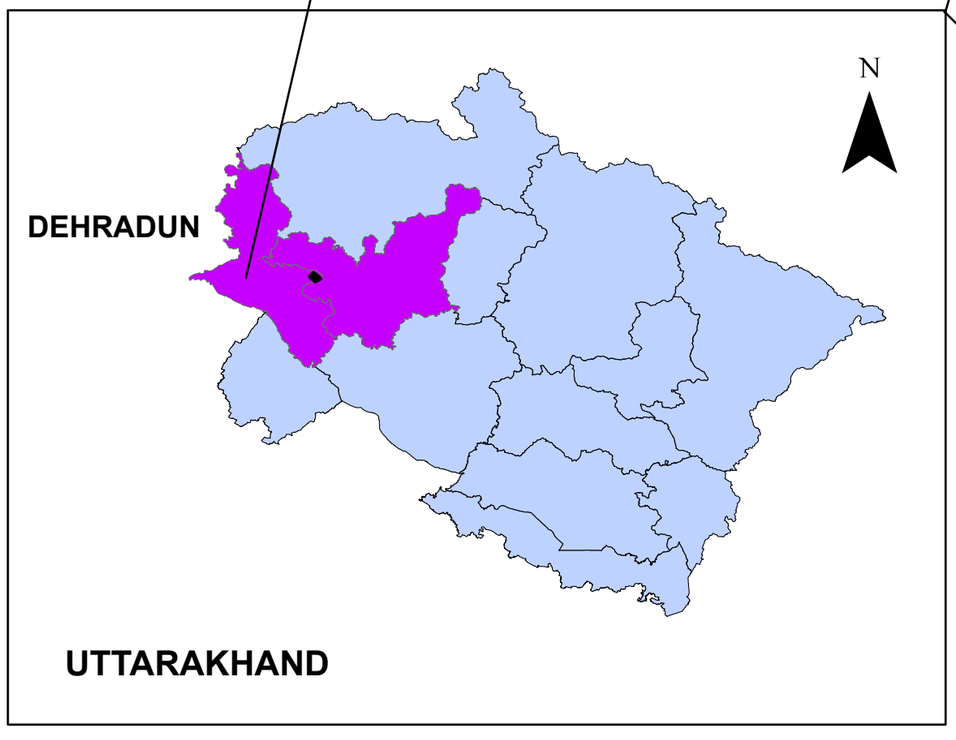
Lithology

- ARGILLACEOUS LIMESTONE AND CLAY
- BASIC ROCKS (DOLERITE DYKE)
- CARBONACEOUS SHALE, SLATE, GREYWACKE
- CONGLOMERATE, IMPERSISTENT SANDSTONE AND CLAY
- DIAMICTITE, QUARTZITE, SLATE AND BOULDER BED
- GRAVEL, PEBBLE AND BOULDER IN OXIDISED SANDY MTRX
- GREY SAND, SILT AND CLAY
- LIMESTONE, DOLOMITIC LIMESTONE WITH SHALE
- MASSIVE SANDY LIMESTONE
- PHYLLITE, QTZ, SHALE,DOLOMITE, TUFF WITH DOLERITE
- QUARTZITE, LIMESTONE AND OCCASSIONAL CONGLOMERATE
- QUARTZITE, SANDY LIMESTONE AND PEBBLE BED
- QUARTZITE, SHALE, PHYLLITE AND CONGLOMERATE
- QUARTZITE, SILTSTONE, CHERT AND PHOSPHATIC SHALE
- SANDSTONE WITH CLAY INTERCALATION
- SANDSTONE, CLAYSTONE, SILTSTONE AND SHALE
- SHALE WITH LENTICLES OF LIMESTONE
- SHALE, QUARTZITE, LIMESTONE AND DOLOMITE
- SPLINTERY SHALE WITH NODULAR LIMESTONE
- <all other values>

Location Map of Kaphalda Block (G-4) for Phosphorite of Mussoorie Syncline, Dist.: Dehradun/Tehri-Garhwal, Uttarakhand (Part of Toposheet Number- 53J/03)







NOT TO SCALE

Kaphalda Block (G-4) (9.46 Sq. Km)		
Block Boundary	LATITUDE	LONGITUDE
A	30.4165°N	78.1765°E
B	30.43264°N	78.19309°E
C	30.40744°N	78.22429°E
D	30.39377°N	78.20189°E

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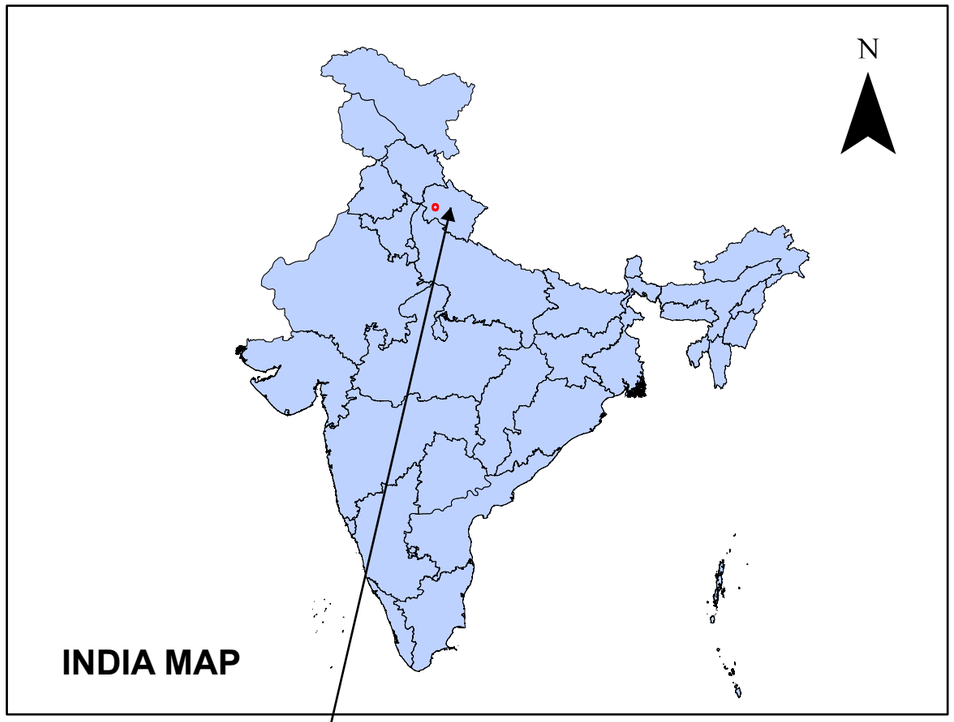
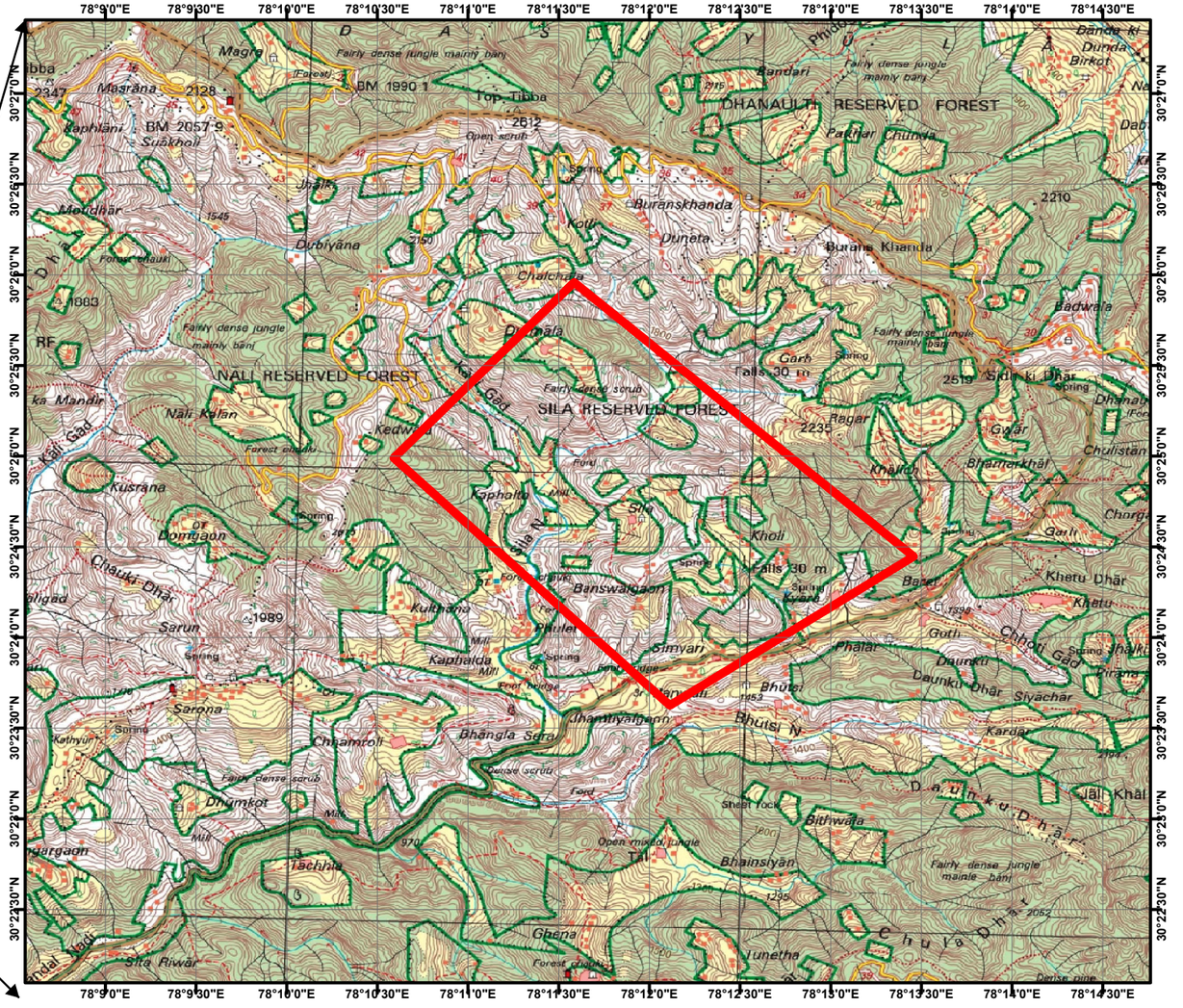
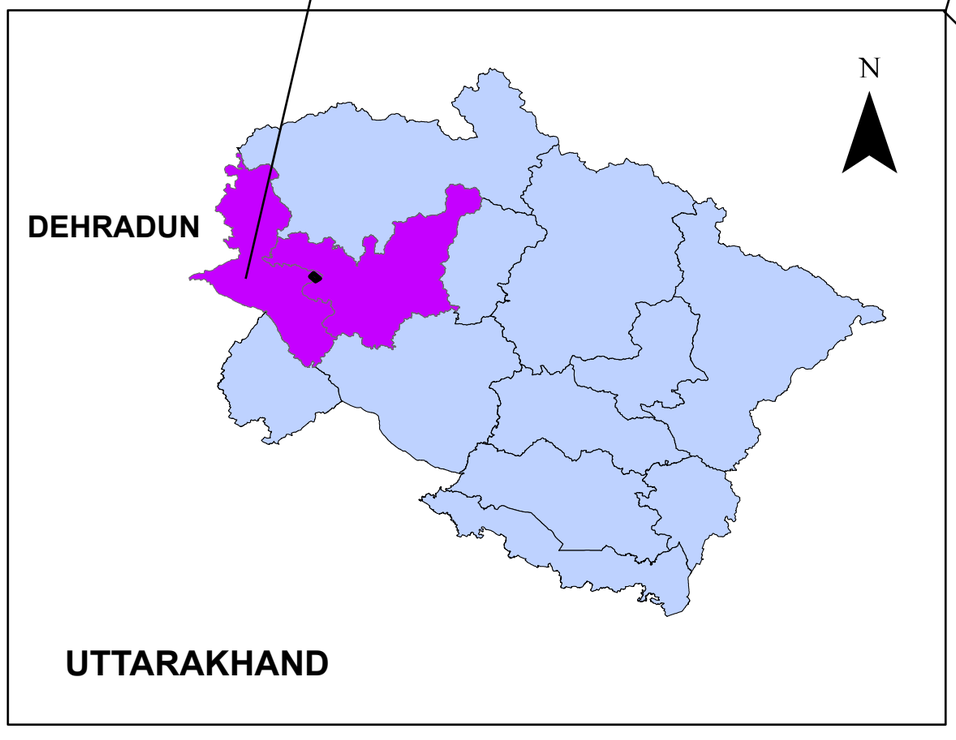
Kaphalda Block_Modified

Location Map of Kaphalda Block (G-4) for Phosphorite of Mussoorie Syncline, Dist.: Dehradun/Tehri-Garhwal, Uttarakhand (Part of Toposheet Number- 53J/03)







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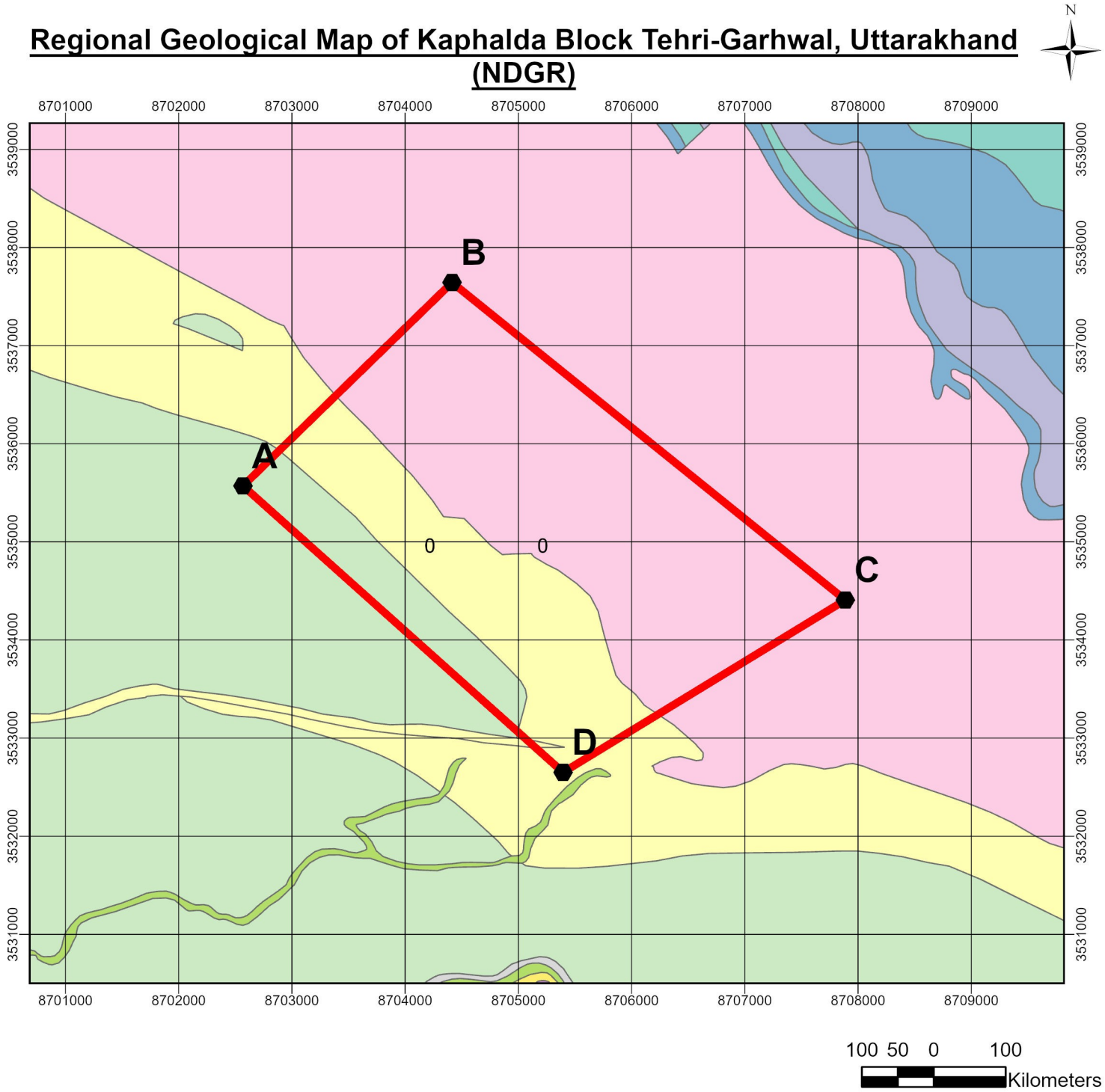
Kaphalda Block_Modified

Regional Geological Map of Kaphalda Block Tehri-Garhwal, Uttarakhand (NDGR)

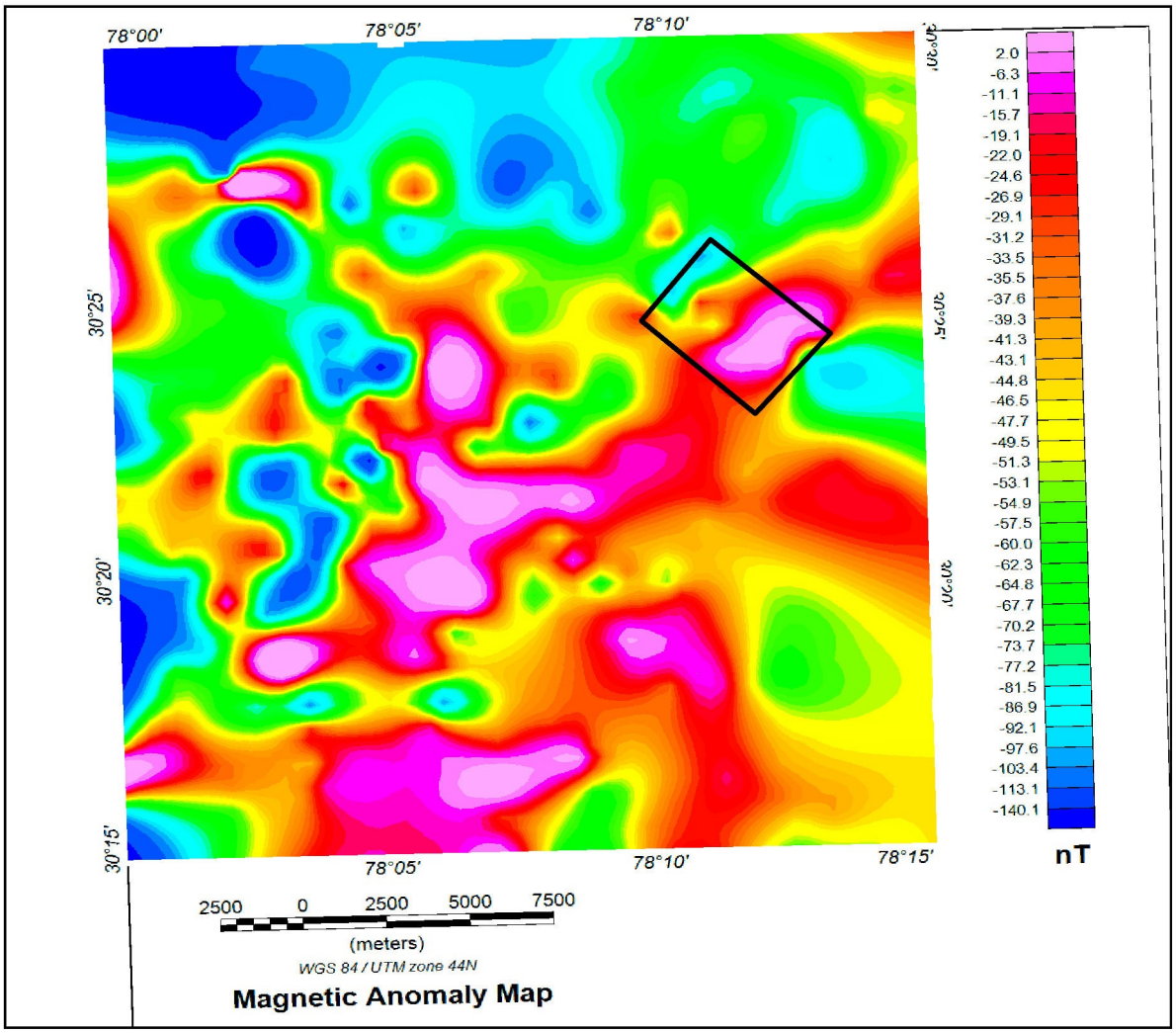


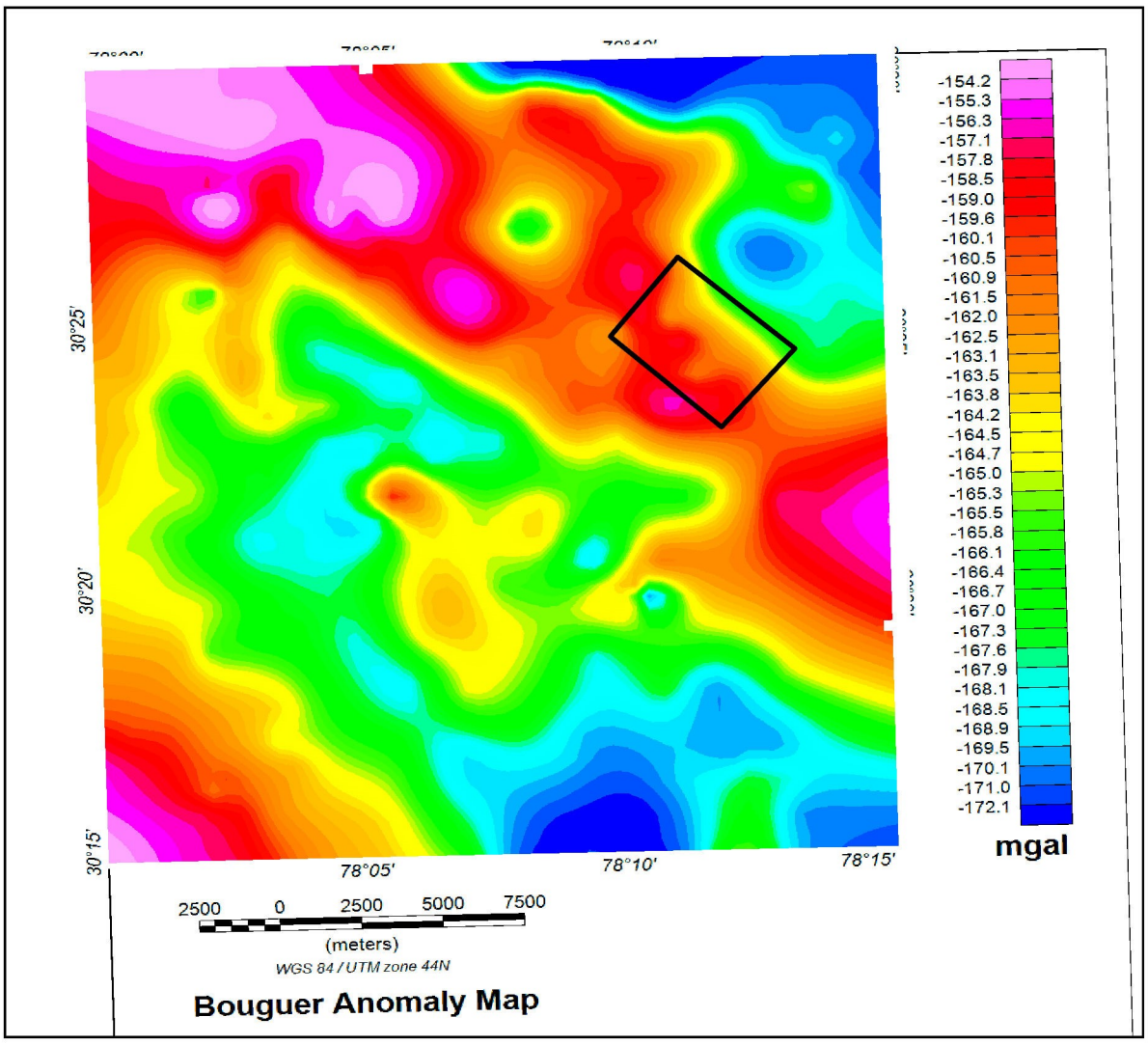
Legend

- Kaphalda Block
- Kaphalda Block Boundary

Lithology

- ARGILLACEOUS LIMESTONE AND CLAY
- BASIC ROCKS (DOLERITE DYKE)
- CARBONACEOUS SHALE, SLATE, GREYWACKE
- CONGLOMERATE, IMPERSISTENT SANDSTONE AND CLAY
- DIAMICTITE, QUARTZITE, SLATE AND BOULDER BED
- GRAVEL, PEBBLE AND BOULDER IN OXIDISED SANDY MTRX
- GREY SAND, SILT AND CLAY
- LIMESTONE, DOLOMITIC LIMESTONE WITH SHALE
- MASSIVE SANDY LIMESTONE
- PHYLLITE, QTZ, SHALE,DOLOMITE, TUFF WITH DOLERITE
- QUARTZITE, LIMESTONE AND OCCASSIONAL CONGLOMERATE
- QUARTZITE, SANDY LIMESTONE AND PEBBLE BED
- QUARTZITE, SHALE, PHYLLITE AND CONGLOMERATE
- QUARTZITE, SILTSTONE, CHERT AND PHOSPHATIC SHALE
- SANDSTONE WITH CLAY INTERCALATION
- SANDSTONE, CLAYSTONE, SILTSTONE AND SHALE
- SHALE WITH LENTICLES OF LIMESTONE
- SHALE, QUARTZITE, LIMESTONE AND DOLOMITE
- SPLINTERY SHALE WITH NODULAR LIMESTONE
- <all other values>


78°00'
78°05'
78°10'
78°15'
30°25'
30°20'
30°15'
2.0
-6.3
-11.1
-15.7
-19.1
-22.0
-24.6
-26.9
-29.1
-31.2
-33.5
-35.5
-37.6
-39.3
-41.3
-43.1
-44.8
-46.5
-47.7
-49.5
-51.3
-53.1
-54.9
-57.5
-60.0
-62.3
-64.8
-67.7
-70.2
-73.7
-77.2
-81.5
-86.9
-92.1
-97.6
-103.4
-113.1
-140.1
nT
2500 0 2500 5000 7500
(meters)
WGS 84 / UTM zone 44N
Magnetic Anomaly Map


78°05'
78°10'
78°15'
30°25'
30°20'
30°15'
-154.2
-155.3
-156.3
-157.1
-157.8
-158.5
-159.0
-159.6
-160.1
-160.5
-160.9
-161.5
-162.0
-162.5
-163.1
-163.5
-163.8
-164.2
-164.5
-164.7
-165.0
-165.3
-165.5
-165.8
-166.1
-166.4
-166.7
-167.0
-167.3
-167.6
-167.9
-168.1
-168.5
-168.9
-169.5
-170.1
-171.0
-172.1
mgal
2500 0 2500 5000 7500
(meters)
WGS 84 / UTM zone 44N
Bouguer Anomaly Map

Time Schedule for Reconnaissance Survey (G-4 Stage Exploration) For Phosphate, REEs and associated trace eelements in Kaphalda Block, Districts: Dehradun & Tehri Garhwal, State: Uttarakhand

		1	2	3	4	5	6		7	8	9	10	11	12
1	Camp Setting	■												
2	Geological Party Days		■	■	■	■	■							
3	Sampling				■	■	■							
4	Sample Preparation				■	■	■							
5	Laboratory Studies						■		■	■	■	■		
6	DGPS survey /BH Fixation						■	Review	■					
7	Core Dilling						■		■	■	■			
8	Core Sample Preparation									■	■			
9	Camp Winding										■			
10	Geologist Party days, HQ											■	■	
11	Geological Report Writing											■	■	■
12	Peer Review													■

* Commencement of project will be reckoned from the day the exploration acreage is available along with all statutory clearances
* Time loss on account of monsoon/agricultural activity/forest clearance/local law and order problems will be addition to above time line

Cost Estimate of Reconnaissance Survey (G-4 Stage Exploration) For Phosphate, REE & associated Trace elements in Kaphalda Block, Districts: Dehradun & Tehri Garhwal, State: Uttarakhand

Total Area - 16.68 sq km; Completion Time -12 Months, Review after 6th Month, Drilling 500 m, BH 5 Nos

S.N	Item of Work	Unit	Rates as per NMET SoC 2020-21			Estimated Cost of the		Remarks
			SoC-Item -Sl No.	Rates as per SoC	Rate@3.35 times for Himalya region	Qty.	Total Amount (Rs)	
A	**GEOLOGICAL WORK**							
a	Charges for Geologist at field for Large scale mapping (1: 12,500), Surface sampling and drilling	day	1.2	11,000	36,850	180	66,33,000	
b	Labour Charges for Geologist;	day	5.7	526	1,762	360	6,34,356	Amount will be reimburse as per the notified rates by the Central Labour Commissioner or respective State Govt. whichever is higher
c	Charges for Sampler for geochemical, channel samples	one sampler per day	1.5.2	5,100	17,085	32	5,46,720	
d	Labour Charges for Sampling Work; Base rate - Rs. 526/ per day	day	5.7	526	1,762	128	2,25,549	Amount will be reimburse as per the notified rates by the Central Labour Commissioner or respective State Govt. whichever is higher
e	DGPS Survey for BH fixation & RL determination	Per Point of observation	1.6.2	19200	64,320	5	3,21,600	5 Core Drill BHs
	Sub-Total A				-		**83,61,225**	
B	**PITTING AND TRENCHING**				-			
a	TRENCHING	Cu m	2.1.2	3,800	12,730	100	**12,73,000**	
C	**DRILLING**				-		-	
1	Core Drilling up to depth of 300 m - Medium hard Rock	m	2.2.1.3	10,100	33,835	500	1,69,17,500	
2	Land / Crop Compensation (in case the BH falls in agricultural Land)	per BH	5.6	20,000	67,000	5	3,35,000	
3	Construction of concrete Pillar (12"x12"x30")	per borehole	2.2.7a	2,000	6,700	5	33,500	
4	Transportation of Drill Rig & Truck associated per drill	Km	2.2.8	36	121	3,000	3,61,800	Approx 3000 km to & fro from Nagpur/ Rig
5	Monthly Accomodation Charges for drilling Camp (up to 2 Rigs)	month	2.2.9	50,000	1,67,500	3	5,02,500	
6	Drilling Camp Setting Cost	Nos	2.2.9a	2,50,000	8,37,500	1	8,37,500	
7	Drilling Camp Winding up Cost	Nos	2.2.9b	2,50,000	8,37,500	1	8,37,500	
8	Road Making (Hilly Terrain)	Km	2.2.10b	32,200	1,07,870	5	5,39,350	
	Sub-Total C						**2,03,64,650**	
D	**Sub Total A to C**						**2,99,98,875**	
E	**Charges for Geologist at HQ for data processing**	**day**	**1.3**	**9,000**		**30**	**2,70,000**	
F	**LABORATORY STUDIES**							
1	**Chemical Analysis**							
i)	**Primary Samples Surface + BH Core Samples**							
	Phospharite (P2O5%, CaO%, MgO%, Na2O%, K2O%, MnO%, SiO2%, Al2O3%, Fe2O3% & LOI%.) by XRF	Nos	4.1.14	4,200		200	8,40,000	Surface samples-100, BH Core-100
ii)	**External check samples (10%)**							
	Phospharite (P2O5%, CaO%, MgO%, MnO%, SiO2%, Al2O3%, Fe2O3% & LOI%.) by XRF	Nos	4.1.14	4,200		20	84,000	
iii)	**REEs & Trace Elements Ananlysis by ICPMS**							
	REEs and associated Trace Elements Ananlysis by ICPMS	Nos	4.1.15a	7,731		30	2,31,930	REE & associated trace elements -30
2	**Physical & Petrological Stusies**							
i)	Preparation of thin section	Nos	4.3.1	2,353		10	23,530	
ii)	Complete petrographic study report	Nos	4.3.4	4,232		10	42,320	
iii)	Preparation of polish section	Nos	4.3.2	1,549		10	15,490	
iv)	Complete mineragraphic study report	Nos	4.3.4	4,232		10	42,320	
v)	Digital Photographs	Nos	4.3.7	280		10	2,800	
vi)	XRD Study	Nos	4.5.1	4,000		30	1,20,000	
	Sub-Total -F						**14,02,390**	
G	**Total D+E+F**						**3,16,71,265**	
H	**Geological Report Preparation**	**5 Hard copies with a soft copy**	**5.2**	For the projects having cost exceding Rs 300 Lakh, A minimum of Rs 9.0 Lakh or 3% of the work whichever more and Rs 10000/- per each additional copy			**9,50,138**	EA has to submit the final Geological Report in Hard Copies (5 Nos) and the soft copy to NMET.
I	**Peer review Charges**		**As per EC decision**				**30,000**	
J	**Preparation of Exploration Proposal (5 Hard copies with a soft copy)**	**5 Hard copies with a soft copy**	**5.1**	**2% of the Cost or Rs. 5.00 Lakhs whichever is lower**			**5,00,000**	EA has to submit the Hard Copies and the soft copy of the final proposal along with Maps and Plan as suggested by the TCC-NMET in its meeting while clearing the proposal.
K	**Total Estimated Cost without GST**						**3,31,51,403**	
L	**Provision for GST (18% of L)**	**%**					**59,67,252**	GST will be reimburse as per actual and as per notified prescribed rate
M	**Total Estimated Cost with GST**						**3,91,18,655**	
						or Say Rs. , In Lakhs:	***391.19***	
Note:								
$	Trenching/Pitting dimensions are tentative may vary depending upon the geology and field conditions							
#	2nd level of work shall be carried out after review of 1st level work i.e. Geological mapping, geochemical sampling and analysis							

Note - If any part of the project is outsourced, the amount will be reimbursed as per the Paragraph 3 of NMET SoC and Item no. 6 of NMET SoC. In case of execusion of the project by NEA on its own, a Certifiate regarding non